

# NUCLEAR SCIENCE ABSTRACTS

Vol. 8, No. 3, February 15, 1954

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## CALENDAR OF MEETINGS

Suggestions for additions to this list will be welcomed and should be sent with all pertinent information to the Cataloging Branch, Technical Information Service, U. S. Atomic Energy Commission, P. O. Box 62, Oak Ridge, Tennessee.

March 15-19, 1954

ELEVATED TEMPERATURE CORROSION SYMPOSIUM, Municipal Auditorium, Kansas City, Mo. Sponsored by: National Association of Corrosion Engineers-10th Annual Conference

Inquiries should be addressed to: Glenn A. Fitzlen, Ass't. Technical Director, Haynes Stellite Company, Kokomo, Indiana.

June 20-25, 1954

NUCLEAR ENGINEERING CONFERENCE, University of Michigan, Ann Arbor, Michigan, Sponsored by: American Institute of Chemical Engineers.

Inquiries should be addressed to: Professor Donald Katz, University of Michigan, Department of Engineering, Ann Arbor, Michigan.

July 19-24, 1954

SECOND RADIOISOTOPE CONFERENCE (a conference on the peaceful uses of atomic energy), Oxford, England,

Arranged by: The Atomic Energy Research Establishment, Harwell.

Inquiries should be addressed to: The Conference Secretary, Atomic Energy Research Establishment, Harwell, Didcot, Berks, England.



## SELECTED SUBJECTS OF INTEREST TO INDUSTRY

All AEC reports abstracted in this issue of Nuclear Science Abstracts have been reviewed and evaluated in terms of their interest and usefulness to general industry. These reports are listed below by title, author, and report number under one or more of the following nine broad categories: Chemistry and Chemical Engineering; Construction and Civil Engineering; Electronics and Electrical Engineering; Health and Safety; Industrial Management; Mechanics and Mechanical Engineering; Metallurgy and Ceramics; Mining and Geology; and Nuclear Technology. The abstract number for each report is listed at the upper right of the entry and refers to an item in the current issue of NSA.

All unclassified reports considered to be of special interest to general industry issued by the AEC prior to July, 1953 are listed or abstracted in a series of bibliographies (TID-3050), the titles of which correspond to the above-mentioned categories. As these background bibliographies become available for sale, the prices will appear in the Numerical Index of Reports which is included in each issue of this volume of NSA. These bibliographies may be purchased from the U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C.

Reproduction in whole or part of any report listed herein is encouraged by the United States Atomic Energy Commission, subject to the approval of authors or originating sites. General inquiries from the industrial press about AEC-developed information may be directed to the Industrial Information Branch, AEC, Washington 25, D. C.

### CHEMISTRY AND CHEMICAL ENGINEERING

AECU-2729 8-774  
Stanford Research Inst.

SELECTED LIST OF REFERENCES REVIEWED DURING  
THE STUDY OF COUNTERCURRENT ION EXCHANGE.  
TECHNICAL REPORT NO. 8. Nevin K. Hiester and Russell  
C. Phillips. June 29, 1953. 20p. Contract AT(11-1)-110,  
Report No. 33. (AECU-2729)

AECU-2751 8-775  
Stanford Research Inst.  
ION EXCHANGE OF TRACE COMPONENTS IN A COUNTER-  
CURRENT EQUILIBRIUM STAGE CONTACTOR. TECHNICAL  
REPORT NO. 3. Nevin K. Hiester, Russell C. Phillips,  
Earl F. Fields, Raymond K. Cohen, and Shirley B. Radding.  
Apr. 1, 1953. 35p. Contract AT(11-1)-110, Report No. 26.  
(AECU-2751)

COO-196 8-703  
Engineering Research Inst., Univ. of Mich.  
UTILIZATION OF THE GROSS FISSION PRODUCTS.  
PROGRESS REPORT NO. 5. L. E. Brownell, L. C.  
Anderson, H. J. Gomberg, L. L. Kempe, J. J. Martin,  
W. W. Meinke, J. V. Nehemias, R. B. Morrison, L.  
Thomassen, G. J. Van Wylen, E. T. Vincent, and R. A.  
Wolfe. Sept. 1953. 202p. Contract AT(11-1)-162.  
(COO-196)

MTA-35 8-776  
Livermore Research Lab., Calif. Research and Develop-  
ment Co.  
CALCULATION OF STAGewise CONTACTING SYSTEMS.  
J. L. Bloom and P. L. Auer. May 22, 1953. 45p. (MTA-35)

NAA-SR-253 8-800  
North American Aviation, Inc.  
CIRCULATION OF LEAD-BISMUTH EUTECTIC AT

INTERMEDIATE TEMPERATURES. R. Cygan. Issued  
Oct. 1, 1953. 22p. Contract AT(11-1)-GEN-8. (NAA-  
SR-253)

ORNL-1628 8-777  
Oak Ridge National Lab., Y-12 Area  
FRACTIONAL SEPARATION OF RARE EARTHS BY  
PRECIPITATION WITH MANDELIC ACID. Boyd Weaver.  
Issued Dec. 4, 1953. 15p. Contract W-7405-eng-26.  
(ORNL-1628)

ORNL-1629 8-778  
Oak Ridge National Lab., Y-12 Area  
FRACTIONAL SEPARATION OF RARE EARTHS BY  
OXALATE PRECIPITATION FROM HOMOGENEOUS SOLU-  
TION. Boyd Weaver. Issued Dec. 4, 1953. 12p. Contract  
W-7405-eng-26. (ORNL-1629)

### ELECTRONICS AND ELECTRICAL ENGINEERING

MTA-37 8-783  
Livermore Research Lab., Calif. Research and Develop-  
ment Co.  
AN AUTOMATIC COUNT AND CONTROL SYSTEM FOR A  
BETA-RAY SPECTROMETER. J. L. Olsen and G. D.  
O'Kelley. Issued Sept. 1953. 20p. Contract AT(11-1)-74.  
(MTA-37)

### METALLURGY AND CERAMICS

BMI-883 8-811  
Battelle Memorial Inst.  
CREEP STRENGTH OF BORAL SHEET AT 200, 400, AND  
600 F. H. A. Saller, J. A. VanEcho, and J. T. Stacy.  
Nov. 23, 1953. 14p. Contract W-7405-eng-92. (BMI-883)

Ames Lab.

Ames Lab.  
PREPARATION OF VANADIUM METAL. John R. Long  
and Harley A. Wilhelm. Aug. 1951. 62p. Contract W-7405-  
eng-82. (ISC-244)

STABILITY OF ZIRCONIUM OXIDE IN GRAPHITE  
SURROUNDINGS. D. R. Wilder and E. S. Fitzsimmons.  
Sept. 1, 1953. 15p. (ISC-403)



An asterisk preceding the abstract number indicates that the corresponding report is included in the "Selected Subjects of Interest to Industry" section of this issue.

## GENERAL

702

Tennessee Univ.

EDGE-PUNCHED CARDS FOR SCIENTIFIC LITERATURE REFERENCES. S. L. Hood, R. A. Monroe, and W. J. Visek. [1953]. 21p. Contract AT(40-1)-GEN-242. (ORO-102)

A proposed system featuring a card design which has area, or fields, devoted to nonexclusive recovery and other areas which may be used in exclusive systems for recovering material from scientific literature is discussed. A basic method of word coding and punching, general features of card design and use, special features of the card, subject indexing and coding, author and literature coding, number fields, difficult subject examples, and starting files are presented. (J.A.G.)

## RESEARCH PROGRAMS

\*703

Engineering Research Inst., Univ. of Mich.

UTILIZATION OF THE GROSS FISSION PRODUCTS. PROGRESS REPORT NO. 5. L. E. Brownell, L. C. Anderson, H. J. Gomberg, L. L. Kempe, J. J. Martin, W. W. Meinke, J. V. Nehemias, R. B. Morrison, L. Thomassen, G. J. Van Wylen, E. T. Vincent, and R. A. Wolfe. Sept. 1953. 202p. Contract AT(11-1)-162. (COO-196)

Progress is reported in experimental studies of the effects of radiation on combustion; the performance of combustion engines under the influence of radiation; the effects of radiation on the chemical reactions during polymerization of ethylene and the chlorination of benzene and toluene; dosimetry studies on 1- and 10-kc  $\gamma$  sources; effects on animals of a diet of irradiated food; the control of trichinosis infections in pork by irradiation, and cost estimates for a pork processing-irradiating plant; the nutritive value of irradiated media for protozoa with essential amino acid and vitamin B needs similar to those of man; the effects of radiation on rubber and on polymerization; and the radiosterilization of bacteriological culture media. Shielding of a 10-kc  $\gamma$  source, and studies on the use of polyvinyl chloride films in  $\gamma$  dosimetry are also discussed. (For preceding period see COO-124.) (C.H.)

## BIOLOGY AND MEDICINE

704

Brookhaven National Lab.

ACINIC CELL ADENOCARCINOMA OF PAROTID. REPORT OF 27 CASES. John T. Godwin, Frank W. Foote, Jr., and Edgar L. Frazell; Brookhaven National Lab. and

Memorial Center for Cancer and Allied Diseases, New York. [1953] 37p. (BNL-1582)

The clinical and pathological features of 27 cases of acinic-cell salivary gland adenocarcinoma of the parotid are summarized. Methods of treatment are discussed briefly. (C.H.)

705

Naval Medical Research Inst., Bethesda

SUMMARY OF THE HISTO-CHEMICAL TECHNIQUES EMPLOYED BY THE PHARMACOLOGY DIVISION OF THE NAVAL MEDICAL RESEARCH INSTITUTE IN THE STUDY OF TOXIC CHANGES PRODUCED BY TOTAL BODY X-IRRADIATION AND BY DRUGS. J. W. Blagg. May 27, 1953. 13p. (NM-006-012.04; Memo Report 53-9)

General tissue processing and staining techniques as employed by the Pharmacology Div. of the Naval Medical Research Inst. are described step by step to serve as an elementary working manual and as a detailed reference for future publications. (auth)

## RADIATION EFFECTS

706

Brookhaven National Lab.

STUDIES ON INDUCED MUTATION IN MAIZE. E. J. Dollinger. [1953?] 57p. (BNL-1622)

Results are reported from investigations of the nature of radio-induced mutations at certain selected chromosomal loci in maize. (auth)

707

Brookhaven National Lab.

HISTOLOGICAL EFFECTS UPON THE PARS ANTERIOR OF THE RAT FOLLOWING HYPOPHYSEAL CATHODE-RAY IRRADIATION AND WHOLE-BODY X-IRRADIATION. G. M. Mateyko, Washington Square Coll. of Arts and Science, New York Univ. and H. A. Charipper, Brookhaven National Lab. [1953?] 39p. (BNL-1624)

The cytology and distribution of the cellular varieties in the adenohipophysis of the male rat were investigated subsequent to total-body x irradiation and pituitary gland irradiation. To ensure irradiation of the hypophysis to the exclusion of adjacent tissues, a beam of cathode-ray particles was delivered directly to the pituitary gland by a collimator designed to fit above the basisphenoid bone. Observations made on the lethal effects of hypophyseal irradiation, the alterations in cellular ratios, and the cytological changes indicate that the pituitary gland is a radiosensitive tissue. (C.H.)

708

School of Aviation Medicine

MECHANISMS OF HYPERSENSITIVITY AND THEIR SIGNIFICANCE IN RELATION TO CERTAIN ASPECTS OF THE RADIATION SYNDROME: A CRITICAL REVIEW. REPORT NO. 1. Kenneth L. Burdon, School of Aviation Medicine and Baylor Univ. Coll. of Medicine. Aug. 1953. 44p. Contract AF 33(038)-15985. (NP-4978)

Reasons are given for the belief that an understanding



of the intimate mechanism of allergic reactions might throw considerable light upon some of the basic biologic changes which occur in radiation sickness. Selected papers from the extensive literature on hypersensitivity and related topics are reviewed. Critical comparisons are made between the prevailing cellular-histamine theory of allergy, the humoral(anaphylatoxin) theory, and the protease-activation theory. The probable usefulness of the newer experimental methods and theoretical concepts developed in the study of the latter theory in elucidating some of the basic mechanisms involved in the radiation syndrome is discussed. 420 references. (auth)

709

Naval Radiological Defense Lab.

PERFORMANCE STUDIES ON ANIMALS SUBJECTED TO IONIZING RADIATION. (SEMI ANNUAL PROGRESS REPORT FOR THE MEDICAL DEPARTMENT OF THE UNITED STATES AIR FORCE) JUNE 30, 1951 TO JUNE 30, 1952. July 15, 1952. 21p. (USNRDL-356; ATI-163404)

710

Naval Radiological Defense Lab.

COMBINED EFFECTS OF TOTAL BODY X IRRADIATION AND RADIANT ENERGY THERMAL BURNS: 1. STUDY OF BLOOD COAGULATION. W. M. Davis, A. K. Davis, W. Lee, and E. L. Alpen. Oct. 22, 1953. 24p. (USNRDL-413; AFSWP-473)

The effects of high intensity radiant energy thermal burns, total-body x irradiation, and of combinations of thermal burns and total-body x irradiation upon the blood coagulation mechanism have been investigated in rats. Total-body x irradiation at a dose of 500 r produces a rapidly developing thrombocytopenia and a defective clotting mechanism as measured by Lee-White and heparin clotting times. At a dose level of 100 r a brief thrombocytosis is followed by a transient mild thrombocytopenia. The high-intensity radiant energy thermal burns alone produce a brief fall in the level of circulating platelets followed by a sustained thrombocytosis. The combined effects of thermal burns and total-body x irradiation consist of the same initial fall of platelets seen in burns alone followed by the same degree of thrombocytopenia seen in animals receiving total-body x irradiation at the particular dose given. However, the clotting defect, as measured by the Lee-White and heparin clotting times, is not so severe in the combined injury animals. The observed defective coagulation mechanism fails to account for the reported enhanced mortality seen in combined-injury animals. However, the thrombocytopenia and defective clotting mechanism does permit the recognition of casualties in which burns or other traumata are complicated by the occurrence of super-imposed total-body x irradiation. (auth)

711

Naval Radiological Defense Lab.

INCREASED TOLERANCE TO HYPOXIA IN IRRADIATED AND IN FOOD DEPRIVED RATS. B. D. Newsom and D. J. Kimeldorf. Aug. 6, 1953. 20p. (USNRDL-414)

The survival rates for groups of rats exposed to lethal levels of hypoxia in an altitude-simulating chamber were determined at various intervals after x irradiation. Irradiated rats were significantly more resistant to the lethal effects of hypoxia than nonirradiated controls. This effect disappears approximately 5 days following 500 or 600 r total-body irradiation. Since the increase in tolerance occurred during the post-irradiation anorectic period, a study was made to determine the effects of food deprivation upon the hypoxic tolerance of nonirradiated animals. When deprived of food for 72 hr nonirradiated animals exhibited an increase in hypoxic tolerance comparable to that of irradiated animals. (auth)

712

THE EFFECT OF ROENTGEN RADIATIONS ON THE CONNECTIVE BASOPHILE GRANULOUS CELLS (MASTZELLEN) OF THE SKIN OF MAN. Alessandro Novaro. Translated from *Radioter. Fis. med.* 8, 69-74(1952). 4p. (AEC-tr-1737)

An abstract of this paper appears in Nuclear Science Abstracts as NSA 7-723. (J.S.R.)

713

THE EFFECT OF RADIATION WITH HIGH DOSES OF X-RAY ON THE CONNECTIVE BASOPHILE GRANULOUS CELLS. Massimiliano Campani. Translated from *Boll. soc. med.-chir. Modena* 48, 3-8(1948). 3p. (AEC-tr-1745)

Intense whole-body irradiation with x rays has the effect of increasing the liberation of metachromatic granules from the connective basophile granulous cells in the skin of mice and of causing their diffusion in the surrounding tissues. (auth)

714

THE EFFECT OF LOW AND HIGH X-RAY DOSAGE ON THE ASCORBIC ACID CONTENT OF THE SUPRARENAL. A. Hochman and L. Bloch-Frankenthal. *Brit. J. Radiol.* 26, 599-600(1953) Nov.

The ascorbic acid content of the adrenals of rats is decreased after total-body irradiation with high and low doses of x rays. Low doses and high doses exerted an equal effect in this respect. The therapeutic effect of x rays on some ailments is discussed. (auth)

715

A STUDY OF THE PHASES OF RADIATION RESPONSE IN THE RAT. II. THE EFFECTS OF NON-UNIFORM IRRADIATION. L. F. Lamerton, L. A. Elson, and E. B. Harriss. *Brit. J. Radiol.* 26, 568-76(1953) Nov.

Studies have been made of the response of young growing rats to uniform whole body x irradiation, and to nonuniform irradiation. Various patterns of radiation dose in the animal have been obtained by partial body shielding during external irradiation and by the administration in various ways of radioactive isotopes which are to some degree preferentially localized in various organs. The changes in the growth curves of the rats under these different patterns of irradiation, together with the blood changes, allow a study to be made of the factors controlling the severity of the initial phase of radiation response which occurs in the first day or so following irradiation, and the second or acute reaction which may commence 10 days or so after irradiation. It has been found that there is in general a correlation existing between the severity of the acute phase of response and the severity of the radiation-induced anemia. The acute phase of the response is much more marked under conditions of uniform whole body irradiation than with partial body irradiation. Some preliminary investigations on the nature of the radiation-induced anemia, using radioactive Fe, are described. (See also NSA 8-53.) (auth)

#### RADIATION HAZARDS AND PROTECTION

716

RADIATION HAZARDS FROM THE USE OF DENTAL X-RAY UNITS. W. E. Nolan and H. W. Patterson. *Radiology* 61, 625-96(1953) Oct.

Potential hazards to dentists, technicians, and patients during dental roentgenography were investigated. Recommendations for safe procedures are presented. (C.H.)

717

RENAL DAMAGE IN X-RAY THERAPY. J. W. J. Carpenter. *Radiology* 61, 649-50(1953) Oct.

The dangers of overdosage to the kidneys during x irradiation of the abdomen are reviewed. (C.H.)



## RADIOTHERAPY

718

A STUDY OF GALLIUM<sup>72</sup>. Marshall Brucer, Gould A. Andrews, and H. D. Bruner. *Radiology* 61, 534-613(1953) Oct.

The therapeutic uses of Ga<sup>72</sup> in the treatment of bone tumors were investigated. Problems encountered, results obtained, the studies completed, and the resulting clinical judgments are summarized. From results of the study it was concluded that Ga<sup>72</sup> is not a therapeutic agent in cancer of the bone. (C.H.)

719

THE TOLERANCE IN HUMANS OF INTRABRONCHIALY ADMINISTERED RADIOACTIVE SILVER-COATED GOLD COLLOIDS. P. F. Hahn, G. W. Hilliard, and E. L. Carothers. *Brit. J. Radiol.* 26, 595-8(1953) Nov.

The intrabronchial administration of radioactive Au and Ag-coated radioactive Au colloids has been described briefly. These materials appear to be well tolerated in the human in quantities used. Their use as adjunct therapy with pneumonectomy in treatment of bronchiogenic carcinoma is suggested. (auth)

## TOXICOLOGY STUDIES

720

Atomic Energy Research Establishment, Harwell, Berks (England)

PRELIMINARY ELECTRON MICROSCOPE MEASUREMENTS OF PARTICLE SIZE IN BERYLLIA. C. S. Lees and S. R. Morgan. Mar. 1951. 13p. (AERE-G/M-77)

The results of electron microscope studies of particle size of various types of BeO are reported. The effects of particle size distribution and specific surface on the maximum permissible amounts of Be allowable in air are discussed briefly. (C.H.)

## TRACER APPLICATIONS

721

Biophysical Lab., Harvard Medical School

POTASSIUM UPTAKE BY THE DOG ERYTHROCYTE. Howard S. Frazier, Arthur Sicular, and A. K. Solomon. [1953?] 21p. Contract [AT-(30-1)-609]. (AECU-2749)

The characteristics of K exchange by separated dog erythrocytes were investigated by tracer techniques. It was concluded that, in the dog, the K influx depends on K concentration, and the apparent activation energy is 14,100 cal/mole at physiological ambient K concentration. Data are compared with previously determined values for man. (C.H.)

722

Michigan State Coll.

THE ENTRY OF NUTRIENTS THROUGH THE BARK AND LEAVES OF DECIDUOUS FRUIT TREES AS INDICATED BY RADIOACTIVE ISOTOPES (thesis). Robert Lewis Ticknor. 1953. 101p. Contract At(11-1)-159. (AECU-2753)

The leaves and the bark of shoots and branches of several types of fruit trees and tomato plants were treated with solutions containing Ca<sup>45</sup>, P<sup>32</sup>, or K<sup>42</sup> during various seasons of the year. Data are presented on the absorption of the nutrients through the bark and leaves and translocation within the plant tissues. (C.H.)

723

Brookhaven National Lab.

FERMENTATION OF D-XYLOSE-1-C<sup>14</sup> BY FUSARIUM LINI BOLLEY. Martin Gibbs, Vincent W. Cochrane, L. M. Paige, and Harold Wolin, Brookhaven National Lab. and Wesleyan Univ. [1953]. 12p. (BNL-1619)

Resting cells of the fungus *Fusarium lini* Bolley ferment

one mole of D-xylose to equimolar quantities of CO<sub>2</sub>, ethyl alcohol, and acetic acid. This is in contrast to growing cultures which have been reported to yield only ethyl alcohol and CO<sub>2</sub> in a ratio of 1:2. When FIB fermented D-xylose-1-C<sup>14</sup>, only the acetic acid methyl C was found to contain appreciable tracer. This is in agreement with pentose dissimilation by *Lactobacillus pentosus* and *Lactobacillus pentoaceticus* and indicates that molds as well as bacteria cleave the pentose chain into C<sub>2</sub> and C<sub>3</sub> fragments. It is pointed out that if ribulose-5-phosphate is the compound cleaved then the enzyme catalyzing the cleavage is probably not transketolase. (auth)

724

Brookhaven National Lab.

ANAEROBIC DISSIMILATION OF C<sup>14</sup>-LABELED GLUCOSE AND FRUCTOSE BY PSEUDOMONAS LINDNERI. Martin Gibbs and R. D. DeMoss. [1953?]. 20p. (BNL-1626)

Data are presented on the mechanisms of anaerobic dissimilation of glucose and fructose by resting suspensions of *Pseudomonas*. The distribution of C<sup>14</sup> in the fermentation products was determined by radiometric analysis. (C.H.)

725

Brookhaven National Lab.

ADRENAL CHOLESTEROL, LIVER GLYCOGEN, AND WATER CONSUMPTION OF FASTING AND X-IRRADIATED RATS. L. F. Nims and Elizabeth Sutton. [1953?]. 23p. (BNL-1631)

Experiments on hypophysectomized, fasting, and x-irradiated rats have demonstrated that the changes in liver glycogen levels observed after irradiation are due to both an increase in pituitary-adrenal activity and to a decreased food intake. The initial rapid fall in liver glycogen is primarily a result of the anorexia of irradiation. The secondary rise in liver glycogen is a result of increased pituitary-adrenal activity resulting from stimuli arising both from the whole-body irradiation and from the fasting state. Stimuli from the latter two sources seem to be roughly additive. (auth)

## CHEMISTRY

726

Brookhaven National Lab.

KINETICS OF EXCHANGE AND DISPROPORTIONATION REACTIONS IN MERCURIC CYANIDE SOLUTIONS. Richard L. Wolfgang and Richard W. Dodson. [1953?] 32p. (BNL-1623)

The exchange of radioactive Hg between Hg<sup>++</sup> and HgCN<sup>+</sup> ions has been measured and found to be slow. This is in agreement with mechanisms postulated in an earlier study for the exchange reactions between Hg<sup>+</sup> and Hg<sup>++</sup> species. The Hg<sup>++</sup>-HgCN<sup>+</sup> exchange proceeds by two paths: (1) a route consistent with a direct bimolecular mechanism, according to the rate law  $R_1 = 4 \times 10^7 \exp(-11,800/RT) (Hg^{++})(HgCN^+)$  mole/l/min; (2) the reactions involved in the disproportionation equilibrium  $2 HgCN^+ \rightleftharpoons Hg^{++} + Hg(CN)_2$ . The above disproportionation system has also been studied directly. The equilibrium constant has been determined,  $K = (Hg^{++})(Hg(CN)_2)/(HgCN^+)^2 = 5 \times 10^{-2}$  at 25°C. The approach to equilibrium has been followed spectrophotometrically and obeys the rate law  $R_{12} = 6 \times 10^{11} \exp(-17,000/RT) (Hg^{++})(Hg(CN)_2) - 3 \times 10^{10} \exp(17,000/RT) (HgCN^+)^2$  mole/l/min. The value obtained for K has been used to explain the zero-time exchange found in the study of the mercurous-mercuric cyanide



exchange. An explanation is offered for the unusual and perhaps unique nonlability of the mercuric mono- and dicyanide complexes. (auth)

727

Lewis Flight Propulsion Lab., NACA  
VAPOR PRESSURES OF CONCENTRATED NITRIC ACID SOLUTIONS IN THE COMPOSITION RANGE 83 TO 97 PERCENT NITRIC ACID, 0 TO 6 PERCENT NITROGEN DIOXIDE, 0 TO 15 PERCENT WATER, AND IN THE TEMPERATURE RANGE 20° TO 80°C. A. B. McKeown and Frank E. Belles. Sept. 17, 1953. 22p. (NACA-RM-E53G08)

Total vapor pressures were measured for 28 acid mixtures of the ternary system  $\text{HNO}_3$ ,  $\text{NO}_2$ , and water within the temperature range 20 to 80°C and within the composition range 83 to 97%  $\text{HNO}_3$ , 0 to 6%  $\text{NO}_2$ , and 0 to 15% water. The ullage of the apparatus used for the measurements was 0.65. Ternary diagrams showing isobars as a function of composition of the system  $\text{NO}_2$ - $\text{H}_2\text{O}$ - $\text{HNO}_3$  were constructed from experimental and interpolated data for the temperatures 25, 40, and 60°C. (NACA)

728

Research Inst., Temple Univ.  
HIGH TEMPERATURE PROJECT TECHNICAL REPORT NO. 3. POWDERED-METAL FLAMES. Joseph B. Conway and Aristid V. Grosse. Aug. 1, 1953. 77p. Contract N9-Onr-87301. (NP-4962)

As an introduction to the production of metal-powder flames, the thermodynamics of metal combustion are discussed. Data on the heat of combustion and other properties of selected metals and the molar heat capacity of solid metallic oxides are tabulated. In the production of metal-powder flames, stoichiometric concentrations of powdered metals dispersed in  $\text{O}_2$  were employed. The feed device, powder conveying, and torch design are discussed. The characteristics of an oxymetal flame are described. The flames were found to be very effective in the melting of ceramic materials. The oxyaluminum flame has a temperature over 3200°C, and its radiant energy dissipation was measured. Some pressure experiments were made. (J.S.R.)

729

British Whiting Federation. Research Council  
A BIBLIOGRAPHY ON PARTICLE SIZE AND SURFACE AREA DETERMINATION WITH BRIEF ABSTRACTS. BIBLIOGRAPHY NO. 1. G. E. Bessey. May 1950. 46p. (NP-4964)

730

British Whiting Federation. Research Council  
A BIBLIOGRAPHY ON PARTICLE SIZE AND SURFACE AREA DETERMINATION WITH BRIEF ABSTRACTS. PART 2. BIBLIOGRAPHY NO. 1a. G. E. Bessey. 56p. (NP-4965)

731

Columbia Univ.  
A TREATMENT OF CHEMICAL KINETICS WITH SPECIAL APPLICABILITY TO DIFFUSION CONTROLLED REACTIONS. Richard M. Noyes. Nov. 11, 1953. 29p. Contract AT(30-1)-1314. (NYO-3882; CU-2-53-AEC-314-Chem.)

If a molecule is produced in a medium containing molecules able to react with it, its instantaneous reactivity is a function of the time since its formation. At very short times, the reactivity is determined by the conventional "true" rate constant,  $k$ , which is the product of the rate constant for encounters and the probability of reaction during an encounter. At long times ( $10^{-9}$  sec or greater in many liquids), the reactivity falls to a value determined by the "long-time" rate constant,  $k'$ . The constants  $k$  and  $k'$  differ by the factor  $1-\beta'$ , where  $\beta'$  is the probability that a specific pair of molecules separating from a nonreactive encounter will ultimately react with each other. If  $\beta'$  is

small either because there is little chance of reaction per encounter (activation control) or because there is little chance the specific pair will undergo a subsequent encounter (as in gas phase), the two rate constants are virtually identical, and conventional kinetics apply. Equations are developed for the time dependence of the reactivity of a molecule in such a system, and a model is suggested for evaluating the necessary parameters in terms of the relative diffusion coefficient, the encounter diameter, and the root-mean-square displacement distance during diffusion. Application of available kinetic data indicates that diffusive displacements in liquids are of the order of a molecular diameter and take place with a frequency of the order of  $10^{11}$  sec $^{-1}$ . In the quenching of fluorescence and other processes where reactive molecules are produced singly, experimental measurements have given the "long-time" rate constant,  $k'$ . When reactive molecules are produced in pairs, the recombination process in a thermal equilibrium is described by the "true" rate constant,  $k$ ; but  $k'$  has been obtained from all rate measurements on the recombination of pairs produced photochemically. Experiments are suggested for obtaining information on systems during the short time in which the apparent rate constant is changing. (auth)

732

Technical Information Service, AEC  
TRANSLATION TITLE LIST AND CROSS REFERENCE GUIDE. Dec. 15, 1953. 207p. (TID-4025)

A list is presented of translations of technical foreign journal literature in TIS files and of translations not in TIS files but which were assigned AEC-tr numbers. This list designates the primary number for each translation. Cross references and an author index are included. (C.H.)

733

A NEW SIMPLE INTERFEROMETER FOR OBTAINING QUANTITATIVELY EVALUABLE FLOW PATTERNS. (Ein Neues, Sehr Einfaches Interferometer zum Erhalt Quantitativ Auswertbarer Strömungsbilder.) S. F. Erdmann. Translated by J. Vanier from Appl. Sci. Research B2, 149-98(1951-52). 62p. (NACA-TM-1363)

The method described makes it possible to obtain interferometer records with the aid of available schlieren optics by the addition of very simple expedients. Under certain conditions, the interferograms need not be inferior to those obtained by other methods. (However, one fundamental drawback of the method compared to the Mach-Zehnder interferometer lies in a relatively very poor light output.) The method is based on the fundamental concept of the phase-contrast process developed by Zernike but which has been enlarged to such an extent that it practically represents an independent interference method. The two light beams causing the interferences are not separated until immediately before photographing and up to that point are subject to the same effects. The theory is explained on a purely physical basis and illustrated and proved by experimental data. A number of typical cases are cited, and some quantitative results reported. (NACA)

734

THE DETERMINATION OF THE EFFECTIVE COEFFICIENTS OF THE VIBRATIONS OF POLYATOMIC MOLECULES. 2. THE POTENTIAL ENERGY CONSTANTS OF HALOGEN SUBSTITUTED METHANE. P. G. Maslov. Translated by Esther Rabkin from Zhur. Fiz. Khim. 25, 803-13(1951). 22p. (TT-301)

The effective coefficients of the halogen methanes  $\text{CH}_2\text{X}$ ,  $\text{CH}_2\text{X}_2$ ,  $\text{CHX}_3$ ,  $\text{CX}_4$ , ( $\text{X} = \text{Br}, \text{Cl}, \text{F}$ ) were obtained by the method of determinants. By the method of the combined fastest emission the effective coefficients of the iodo-substituted methanes were obtained; also, a calculation



and an interpretation of the frequencies of these molecules were carried out. An error was discovered in the interpretation of the frequencies of the molecule  $\text{CH}_2\text{I}_2$  carried out by Ta-You-Wu. The frequencies 1350, 1130, 1027, and  $713\text{ cm}^{-1}$  assigned by Ta-You-Wu to the vibrations of the type  $\text{B}_2(\delta)$ ,  $\text{A}_1(\alpha\delta)$ ,  $\text{B}_1(\delta)$  and  $\text{A}_2(\delta)$  should be assigned to the vibrations  $\text{A}_1(\alpha\delta)$ ,  $\text{B}_2(\delta)$ ,  $\text{A}_2(\delta)$  and  $\text{B}_1(\delta)$ . It was shown that it is inadmissible to carry out a calculation of the frequencies of molecules by neglecting the nondiagonal effective coefficients. If the super halogen, F, is excluded, then the transitions  $\text{CH}_4 \rightarrow \text{Cl}_4$ ,  $\text{CH}_4 \rightarrow \text{CBr}_4$ , and  $\text{CH}_4 \rightarrow \text{CCl}_4$  for all types of molecules practically do not change the strength of the bond C-H and C-X. The transition  $\text{CH}_4 \rightarrow \text{CF}_4$  increases the strength of the bond C-F by approximately 20% and decreases the strength of the bond C-H. (auth)

735

THE PROBLEM OF THE ELECTROLYTIC DISSOCIATION OF FUSED SALTS. B. F. Markov, Yu. K. Delimarskii. *Ukrain. Khim. Zhur.* 19, 255-63(1953) June. (In Russian)

On the basis of the electric conductivity of fused salts of Be, Mg, Ca, Sr, and Ba at their melting points, the degree of dissociation of these salts was estimated. The dependence of electric conductivity on temperature, the solubility of the metals in salt melts, and the transfer numbers confirm the hypothesis of an incomplete dissociation. Whereas the equivalent conductivity drops between  $\text{LiCl}$  and  $\text{CsCl}$ , it rises between  $\text{MgCl}_2$  and  $\text{BaCl}_2$ . (J.S.R.)

736

HYDROLYTIC POLYMERIZATION OF ZIRCONIUM(IV). Kurt A. Kraus and James S. Johnson. *J. Am. Chem. Soc.* 75, 5769(1953) Nov. 20.

The hydrolytic polymerization of  $\text{Zr}^{+4}$  in chloride and perchlorate solutions was determined from estimation of the polymer charge from ultracentrifugation data. The degree of polymerization was 3.0 in  $1\text{M HCl}$ , 2 to 2.6 in  $3\text{M HCl}$ , and 4 to 5.4 in  $0.1\text{M HCl}$ . In perchlorate solution the most probable degree of polymerization for 0.05 and  $0.12\text{M Zr}^{+4}$  solutions in  $1\text{M HClO}_4$ – $1\text{M NaClO}_4$  was 3. (J.S.R.)

737

THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. I. VAPOR PRESSURES OF TECHNETIUM HEPTOXIDE, PERTECHNIC ACID AND AQUEOUS SOLUTIONS OF PERTECHNIC ACID. Wm. T. Smith, Jr., J. W. Cobble, and G. E. Boyd. *J. Am. Chem. Soc.* 75, 5773-6(1953). Dec. 5.

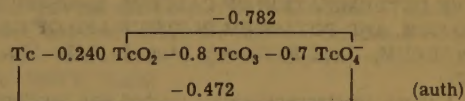
Vapor pressures of  $\text{Te}_2\text{O}_7$ ,  $\text{HTeO}_4$ , and of saturated aqueous solutions of the latter compound were determined using a glass differential Bourdon gage. The vapor pressures between 25 and  $260^\circ$  followed a two-term equation:  $\log p$  (mm) =  $A/T + B$ , with values for A of  $-7205$ ,  $-3571$ ,  $-2395$ , and  $-2375$ , and for B of  $18.28$ ,  $8.999$ ,  $8.207$ , and  $8.201$  for  $\text{Te}_2\text{O}_7(\text{c})$ ,  $\text{Te}_2\text{O}_7(\text{l})$ ,  $\text{HTeO}_4(\text{c})$ , and  $\text{HTeO}_4(\text{sat.})$ , respectively. Values for enthalpy, entropy, and standard free energy changes in the fusion, vaporization, sublimation, and solvation of these compounds were estimated and compared with corresponding quantities for analogous Re compounds. In general, the properties of Tc and analogous Re compounds were closely similar as expected from their positions in the periodic table. (auth)

738

THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. II. HEATS OF FORMATION OF TECHNETIUM HEPTOXIDE AND PERTECHNIC ACID, POTENTIAL OF THE TECHNETIUM(IV)-TECHNETIUM(VII) COUPLE, AND A POTENTIAL DIAGRAM FOR TECHNETIUM. J. W. Cobble, Wm. T. Smith, Jr., and G. E. Boyd. *J. Am. Chem. Soc.* 75, 5777-82(1953). Dec. 5.

The thermodynamics of Tc and some of its compounds

have been studied by semimicro calorimetry and potentiometry using Mg quantities of the element. The heat of formation of  $\text{Tc}_2\text{O}_7(\text{c})$  was  $-266.1 \pm 2.6$  kcal/mole, and the potential of the  $\text{TcO}_2$ – $\text{TcO}_4^-$  electrode was  $-0.782 \pm 0.011$  v. When combined with suitable experimental and estimated entropy values, some thirty thermodynamic functions could be calculated for Tc and its compounds. The resultant oxidation-reduction diagram in acid solution is shown.



739

THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. III. HEATS OF FORMATION OF RHENIUM HEPTOXIDE AND TRIOXIDE, AND A REVISED POTENTIAL DIAGRAM FOR RHENIUM. G. E. Boyd, J. W. Cobble, and Wm. T. Smith, Jr. *J. Am. Chem. Soc.* 75, 5783-4(1953). Dec. 5.

Elemental Re and  $\text{ReO}_3$  have been burned in a semimicro bomb calorimeter to redetermine the heats of formation of  $\text{Re}_2\text{O}_7(\text{c})$  and  $\text{ReO}_3(\text{c})$ . These were  $-295.9 \pm 2.0$  and  $-146.0 \pm 3.0$  kcal/mole, respectively. The latter value is in disagreement with that previously reported, but is now consistent with the observed stability of the compound in the presence of water. Using experimental and estimated entropy values and the recently published potential for the  $\text{ReO}_2$ – $\text{ReO}_4^-$  couple, revised thermodynamic functions are given for Re and for some of its compounds. An oxidation-reduction scheme for the element in acid solution is proposed. (auth)

740

THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. IV. LOW TEMPERATURE HEAT CAPACITY AND THERMODYNAMICS OF RHENIUM. Wm. T. Smith, Jr., G. D. Oliver, and J. W. Cobble. *J. Am. Chem. Soc.* 75, 5785-6(1953). Dec. 5.

The low-temperature heat capacity of metallic Re has been measured from 20 to  $300^\circ\text{K}$  by adiabatic calorimetry. The molal entropy was calculated to be  $8.89 \pm 0.03$  cal/mole/deg at  $298.16^\circ\text{K}$ . (auth)

741

THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. V. LOW TEMPERATURE HEAT CAPACITY AND THE THERMODYNAMICS OF POTASSIUM PERRHENATE AND THE PERRHENATE ION. J. W. Cobble, G. D. Oliver, and Wm. T. Smith, Jr. *J. Am. Chem. Soc.* 75, 5786-7(1953). Dec. 5.

The low temperature heat capacity of  $\text{KReO}_4$  has been measured from 16 to  $300^\circ\text{K}$ , and the molal entropy has been calculated to be  $40.12 \pm 0.08$  cal/mole/deg at  $298.16^\circ\text{K}$ . When combined with solubility data and heat of solution measurements, the entropy of the perrhenate ion has been found to be  $48.3$  cal/mole/deg. The free energy of formation of the ion has been calculated to be  $-167,100$  cal/mole. (auth)

## ANALYTICAL PROCEDURES

742

Atomic Energy Research Establishment, Harwell, Berks (England)  
THE ANALYSIS OF URANIUM-TITANIUM ALLOYS.  
G. W. C. Milner and P. J. Phennah. Sept. 23, 1953. 15p.  
(AERE-C/R-1236)

A satisfactory procedure is described for the determination of Ti and U in binary alloys containing from 1 to about 50% of Ti. The primary separation of Ti is effected by the extraction of the cupferrate into chloroform. Traces of U



coextracted with the Ti in this separation are separated by using tannin and then determined absorptiometrically via the U thiocyanate color complex. The major U content is also determined by precipitation with tannin, followed by ammonium diuranate precipitation and ignition to  $U_3O_8$ . (auth)

743

Army Medical Research Lab., Fort Knox  
THE DETERMINATION OF CALCIUM, MAGNESIUM, SODIUM, AND POTASSIUM IN TISSUE AND OF CALCIUM IN SERUM. Jack R. Denson. Aug. 1, 1953. 12p. (AMRL-121)

A flame spectrophotometric method was developed which permits the simultaneous determination of Ca, Mg, Na, and K in tissue. A rapid method for the determination of Ca in blood serum has also been worked out. (auth)

744

Ames Lab.  
ANALYSIS OF URANIUM-ZINC ALLOYS. James S. Fritz, Myron O. Fulda, Sonya L. Margerum, and Elizabeth I. Lane. Nov. 27, 1953. 7p. Contract W-7405-eng-82. (ISC-427)

The method described for analyzing alloys of Zn and U containing up to 20% U is rapid, quantitative, and requires no separation of either component. The U is determined by passing a solution of the alloy through a Pb reductor and then titrating with  $Ce(SO_4)_2$ . The Zn is determined by titrating with Versene, ammonium purpurate being used as the indicator. The U does not interfere in the Versene titration if it is first complexed with carbonate. (auth)

745

Pitman-Dunn Labs., Frankford Arsenal  
COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF ALUMINUM IN TITANIUM ALLOYS. M. Codell and G. Norwitz. [1953?] 16p. (MR-529; AD-153)

746

Engineering Research Inst., Univ. of Mich.  
SPECTROCHEMICAL ANALYSIS OF TITANIUM METAL AND ALLOYS. INTERIM REPORT NO. 3. J. H. Enns. Aug. 1953. 43p. Contract DA-018-ORD-11511. (NP-4958)

The development of a spectrochemical (porous cup) technique for the determination of Al, Mn, Cr and/or Fe in Ti-base alloys in concentrations of from 1 to 7% and for the determination of these and other metals in trace concentrations is presented. The porous-cup-solution technique for the analysis of Fe and Cr in Ti alloys has been extended to include Al and Mn. It is shown that all four elements may be present in concentrations up to 7% each without apparent interference. The spark source parameters were changed slightly to reduce background. The method has been applied to the analysis of three specific alloys each containing two of the above elements in several % concentrations. Necessary corrections are worked out which take into account concentrational differences of the internal standard element, Ti. The method is also extended to include trace analysis for some metals in concentrations as low as 0.002%. (For preceding report in series see NP-4178.) (auth)

747

Johns Hopkins Univ.  
THE ANALYSIS AND PURIFICATION OF RARE GASES BY MEANS OF ELECTRIC DISCHARGES. R. P. Riesz and G. H. Dieke. [1952] 20p. (NP-4967)

Through the phenomenon of cataphoresis in gas discharges, impurities are carried toward the cathode and concentrated there. This can be used for the purification of rare gases, in particular for the removal of traces of one rare gas from another. The same technique can be used for the analysis of rare gases. The high concentration of the impurities near the cathode increases the sensitivity by a

large factor. One part of Ne in 200 million parts of He has been detected without difficulties. (auth)

748

THE DETERMINATION OF SMALL AMOUNTS OF OXYGEN DISSOLVED IN WATER. Jean Verbestal, Armand Berger, and Valere Royer. Translated by Margaret V. Colven from Bull. centre belge étude et document. eaux(Liége) 8, 494-500(1950). 14p. (AEC-tr-1738)

A critical study is made of methods for the determination of trace amounts of dissolved  $O_2$ . Volumetric, indirect absorptiometric, and direct absorptiometric methods are discussed. The colorimetric orthotolidine method appears to be most precise and rapid. (J.S.R.)

749

A SIMPLE RADIOMETRIC METHOD FOR DETERMINATION OF THE ISOTOPE COMPOSITION OF LITHIUM SALTS. Wilfrid Herr. Translated from Z. Naturforsch. 8a, 305-7 (1953). 4p. (AERE-Trans-11/3/5/380)

A brief abstract of this report appears in Nuclear Science Abstracts as NSA 7-4852. (J.S.R.)

750

ION-EXCHANGE SEPARATION OF TRACE IMPURITIES. W. A. Brooksbank and G. W. Leddicotte. J. Phys. Chem. 57, 819-23(1953) Nov.

The use of ion-exchange separations in determining trace elements by neutron activation analysis is described. Activation analysis, coupled with ion-exchange techniques, becomes an extremely sensitive and specific method for the determination of small quantities of the rare earth and alkali elements in the presence of each other. This method has been applied to the analysis of rare earths in animal tissues and to the analysis of the alkali metals in pure chemical compounds and synthetics. (auth)

751

ANALYSIS FOR TRACE IMPURITIES BY NEUTRON ACTIVATION. W. A. Brooksbank, G. W. Leddicotte, and H. A. Mahlman. J. Phys. Chem. 57, 815-19(1953) Nov.

The application of radioactivation analysis to selected examples of trace element determinations is reported. The technique of the method of neutron radioactivation analysis and the sensitivities of detection of these elements in a variety of materials are discussed. (auth)

## ATOMIC WEIGHTS AND PERIODIC SYSTEMS

752

NUMBER OF ISOTOPES AS A FUNCTION OF THE ATOMIC WEIGHTS OF ELEMENTS. E. P. Ozhigov. Zhur. Obshchei Khim. 23, 3-6(1953) Jan. (In Russian)

It is shown that the possible number of isotopes in the periods is a function of the magnitude of the average differences in at. wts. of the elements. A formula is proposed for calculating the number of possible isotopes (without nuclear isomers) in the known part of the periodic system. This formula makes it possible to predict the number of isotopes to be discovered in the next few years and supports Mendeleev's view that the difference in at. wts. may be a "tool for more detailed control of experimental data." The idea that the number of isotopes cannot be determined is refuted. (J.S.R.)

753

THE CLASSIFICATION OF MUTUAL SYSTEMS FORMED OF ALKALI METALS. G. G. Diogenov. Zhur. Obshchei Khim. 23, 20-4(1953) Jan. (In Russian)

The thermal effect of mutual systems formed by alkali metals changes periodically within the limits of groups in Mendeleev's system. The mutual systems possible for alkali metals are classified into 10 types. The type of mutual system is determined by its position in a table made up on the basis of the relative proximity of the alkali metals



in the periodic table. The less the radius of the anion, the greater the deviation from equilibrium in mutual systems. (J.S.R.)

754

IONIC RADII AND IONIZATION POTENTIALS. K. B. Yatsitirskii. *Zhur. Obshchei Khim.* **23**, 180-5(1953) Feb. (In Russian)

An empirical equation which establishes the connection between ionic radii and ionization potential is proposed. The ionic radii for 15 ions were calculated, and some radii were checked by calculating the lattice energy of salts. General rules for changes in radii of equally charged ions in the periodic system of Mendeleev were established. (J.S.R.)

## CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

755

[Division of Research, AEC]  
REPORT ON THE TRIP TO EUROPE OF DR. PETER PRINGSHEIM. Peter Pringsheim. Oct. 28, 1953. 12p. (WASH-151)

Information acquired while visiting research centers in England, Holland, Belgium, and Germany is summarized. Research activities reported include studies on the heat conductivity of crystals, nuclear alignment, thermal conductivity of metals at low temperatures, fluorescence of pure and mixed Ag halides, pile-irradiation of diamonds, electric properties of Pt and Cu<sub>3</sub>Au, effects of radiation on crystal structure of B, luminescence of phosphors, the formation of solid C from vapors under various conditions, the heat of evaporation of C, the properties of ZnS phosphors, the theory of electroluminescence, and the superconductivity of thin metal films deposited on a surface at low temperature. A symposium on semiconductors was attended by the author. (C.H.)

756

DETERMINATION OF THE COEFFICIENT OF DISTRIBUTION OF RADIUM AND OF ITS ISOTOPE ThX BETWEEN THE MELT AND CRYSTALS OF CALCIUM NITRATE. V. G. Khlopin, V. R. Klokman, and E. G. Pekel'naya. *Izvest. Akad. Nauk S.S.S.R. Otdel. Khim. Nauk* No. 2, 250-2(1953) Mar.-Apr. (In Russian)

The coefficient of the distribution of Ra and of its isotope Ra<sup>224</sup> between the melt and the crystals of Ca(NO<sub>3</sub>)<sub>2</sub> was determined. It was shown that in this system there is no enrichment of Ra in the solid phase. Ra(NO<sub>3</sub>)<sub>2</sub> readily forms mixed crystals with the nitrates of Ca and Pb, but not with those of Sr and Ba. There is enrichment of Ra on the crystals of the nitrates of Sr and Ba, but not on the nitrates of Ca and Pb. (J.S.R.)

## DEUTERIUM AND DEUTERIUM COMPOUNDS

757

THE INFRARED ABSORPTION SPECTRA OF DIETHYL KETONE AND ITS DEUTERIUM SUBSTITUTION PRODUCTS. B. Nolin and R. Norman Jones. *J. Am. Chem. Soc.* **75**, 5626-8(1953) Nov. 20.

A comparison of the infrared absorption spectrum of diethyl ketone with the spectra of six deuterium substitution products has permitted the unequivocal identification of the methyl and methylene vibrations in the C-H stretching and C-H bending regions. Bands characteristic of the tri-deuteromethyl and dideuteromethylene group are also identified between 2300 and 2100 cm<sup>-1</sup>. A small but significant lowering of the carbonyl stretching frequency occurs on deuteration of the methylene groups. (auth)

## FLUORINE AND FLUORINE COMPOUNDS

758

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF MAGNESIUM MONOFLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 10p. (NBS-2181)

The ideal-gas thermal properties, heat capacity, entropy, heat content, and free energy for MgF are calculated from spectroscopic data at closely spaced temperature intervals from 50 to 5000°K. (auth)

759

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF ALUMINUM MONOFLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 11p. (NBS-2182)

Spectral data reported by Rochester were used to estimate spectroscopic constants for AlF. These were then used to calculate thermal functions. Heat capacity, entropy, heat content, and free energy functions are tabulated in dimensionless units at closely spaced temperature intervals from 50 to 5000°K. A discussion of the dissociation energy is given; the value D<sub>0</sub> = 2.0 ± 0.5 ev is suggested. (auth)

760

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF SODIUM MONOFLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 9p. (NBS-2183)

761

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF LITHIUM MONOFLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 9p. (NBS-2184)

Ideal gas thermal properties for LiF are calculated from theoretically derived molecular data for the rigid-rotator, harmonic-oscillator approximation. Heat capacity, entropy, heat content, and free energy functions are tabulated in dimensionless units at closely spaced temperature intervals from 50 to 5000°K. (auth)

762

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF SILICON MONOFLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 11p. (NBS-2185)

763

National Bureau of Standards  
THERMAL PROPERTIES OF FLUORINE COMPOUNDS: HEAT CAPACITY, ENTROPY, HEAT CONTENT AND FREE ENERGY FUNCTIONS OF HYDROGEN FLUORIDE IN THE IDEAL GASEOUS STATE. Lester Haar and Charles W. Beckett. June 1, 1953. 11p. (NBS-2186)

Ideal gas thermal functions are calculated for HF from spectroscopic data. Heat capacity, entropy, heat content, and free energy functions are tabulated in dimensionless units at closely spaced temperature intervals from 50 to 5000°K. A brief discussion of the dissociation energy is given, and a value, 134 ± 3 kcal./j is suggested. (auth)



764

National Bureau of Standards

## PROPERTIES OF FLUORINE COMPOUNDS. THE VIBRATIONAL SPECTRUM OF BROMOTRIFLUOROETHYLENE.

D. E. Mann, National Bureau of Standards and N. Acquista and Earle K. Plyler, Atomic Physics Lab., National Bureau of Standards. [1953] 20p. Contract NAonr-112-51. (NBS-2856)

The infrared spectrum of gaseous bromotrifluoroethylene,  $F_3C:CFBr$ , has been investigated in the range 2 to 52  $\mu$ . The assignment of fundamentals parallels that for chlorotrifluoroethylene very closely. The planar vibrational frequencies in  $cm^{-1}$  are 1783( $\nu_{CC}$ ), 1330( $\nu_{CF}$ ), 1203( $\nu_{CF}$ ), 1027( $\nu_{CF}$ ), 659( $\nu_{CBr}$ ), 510( $\delta_{CF_2}$ ), 370( $\delta_{CFBr}$ ), 311( $\rho_{CF_2}$ ), and 160( $\rho_{CFBr}$ ) while the out-of-plane modes are assigned 538( $\beta_{CF_2}$ ), 355( $\beta_{CFBr}$ ), and 150( $\tau$ ). A table of thermodynamic functions for the ideal gas is given. (auth)

765

Pittsburgh Univ.

THE SYNTHESIS OF CERTAIN KETONES AND  $\alpha$ -SUBSTITUTED  $\beta$ -DIKETONES CONTAINING PERFLUOROALKYL GROUPS.

Lloyd B. Barkley and Robert Levine. Issued Dec. 9, 1952. 19p. Contract AT(30-1)-670. (NYO-3382)

766

Minnesota Mining and Manufacturing Co.

## SYNTHETIC RUBBERS FROM CARBON-FLUORIDE COMPOUNDS. F. A. Bovey. Sept. 1953. 205p. AF 33(038)-515. (WADC-TR-52-197(pt.3))

The preparation and properties of fluorine-containing rubbers are described. The object of the work is the development of elastomeric materials which are resistant to the fuels, lubricants, and hydraulic fluids used in military aircraft and which are serviceable over the widest possible temperature range. Copolymers of perfluoro-butadiene with 1,1-dihydroperfluoroalkyl vinyl ethers offer excellent high temperature resistance, low swelling in aircraft fluids, and high resistance to ozone. In addition to the 1,1-dihydroperfluoroalkyl acrylates, which have outstanding solvent resistance but limited low temperature flexibility, newer classes of fluoroacrylates have been synthesized. Of particular interest are the  $\gamma$ -(perfluoroalkoxy)-1,1-dihydroperfluoropropyl acrylates, which offer solvent resistance at least equal to that of the earlier series but are flexible at temperatures 25°C lower than the polymers of the 1,1-dihydroperfluoroalkyl acrylates. In the compounding and vulcanization of fluoroacrylate polymers, the most striking accomplishment has been the development of polyamine curing systems which give greatly improved resistance to aircraft fluids such as diester lubricants at temperatures as high as 350°F, better compression set and other mechanical properties, and greatly improved resistance to  $HNO_3$  and to alkali. Fundamental studies of the copolymerization behavior of the fluoroacrylates, of their swelling in organic liquids, and of their molecular weights are presented. (auth)

767

THERMAL AND ROENTGEN PHASE ANALYSIS OF THE SYSTEM  $LiF-BeF_2$ . A. V. Novoselova, Yu. P. Simanov, and E. I. Yarembach. *Zhur. Fiz. Khim.* 26, 1244-58(1952) Sept. (In Russian)

The  $LiF-BeF_2$  system was analyzed. It was found that  $LiF$  undergoes an enantiotropic polymorphous conversion at  $827 \pm 5^\circ C$ . The melting point of  $LiF$  was  $845 \pm 5^\circ$ . The decomposition point of some binary fluoride compounds was determined.  $2LiF \cdot BeF_2$  ( $Li_2BeF_4$ ) melts and decomposes at  $461 \pm 5^\circ C$ .  $LiF \cdot BeF_2$  ( $LiBeF_3$ ) melts and decomposes at  $353 \pm 5^\circ C$ .  $LiF \cdot BeF_2$  ( $LiBe_2F_5$ ) decomposes at  $277 \pm 5^\circ C$  without melting. Another fluoride was found with the

probable composition of  $5LiF \cdot BeF_2$ . Crystalline  $BeF_2$  melts in a manner similar to glass, first softening at  $577 \pm 10^\circ C$ , and congeals from the melt in the form of glass. In melts with  $LiF$ ,  $BeF_2$  undergoes two polymorphous conversions. Roentgenograms of annealed melts of  $LiF$  and  $BeF_2$ , containing over 65% of  $BeF_2$ , indicate the presence of quartz-like  $BeF_2$  in the melts. (J.S.R.)

768

THE FLUOROPLATINATES. II. FLUOROPLATINIC ACID. Roy S. Clarke, Jr. and Theodore P. Perros. *J. Am. Chem. Soc.* 75, 5734-5(1953) Nov. 20.

Fluoroplatinic acid may be prepared by passing  $La$  fluoroplatinate through an ion exchange column charged with  $H_2$ . The acid is stripped from the resin by elution with water. The acid is hygroscopic and soluble in water. (J.S.R.)

769

DOUBLING OF FLUORINATED CHAINS. Albert L. Henne. *J. Am. Chem. Soc.* 75, 5750(1953). Nov. 20.

The synthesis of highly fluorinated chains was attempted by doubling the chain in the presence of acetic anhydride and  $Zn$ .  $C_6F_{14}$ ,  $C_6H_5Cl_8$ , and  $CCl_3CF_2CCl=CCl_2$  were successfully synthesized, but  $n$ -octane could not be obtained by this method. (J.S.R.)

## LABORATORIES AND EQUIPMENT

770

California Research and Development Co., Livermore  
THE CONTROL OF THE LEVEL OF VOLATILE LIQUID BY DIFFERENTIAL GAS PRESSURE SWITCHES. C. R. Bumstead and R. A. Isberg. Aug. 20, 1952. 3p. (CRD-A8-7)

## RADIATION CHEMISTRY

771

Canisius Coll.

## THE RADIATION INDUCED REACTION BETWEEN IODINE AND HEPTANE. Paul F. Forsyth, Edward N. Weber, and Robert H. Schuler. Apr. 1953. 20p. Contract AT-(30-1)-1084. (NYO-6050)

The radiation-induced reaction between  $I$  and  $n$ -heptane has been studied with a view to its use in the quantitative determination of free radical production in the radiolysis of liquid hydrocarbons. The yield of this reaction has been found to be independent of  $I$  concentration and of temperature of the sample. The reaction is inhibited by the presence of dissolved  $O$ . On a relative basis, it is found that 0.6 moles of  $I$  are absorbed per mole of  $H_2$  produced. From this, it is indicated that free-radical production is a major component of the over-all process and that the primary decomposition yield is of the order of 10 bonds broken per 100 ev of absorbed energy. (auth)

## RARE EARTHS AND RARE-EARTH COMPOUNDS

772

Radiation Lab., Univ. of Calif., Berkeley  
THERMODYNAMICS OF THE TRICHLORIDES AND OXYCHLORIDES OF SOME OF THE LANTHANIDE AND ACTINIDE ELEMENTS (thesis). Charles William Koch. Sept. 1953. 101p. Contract W-7405-eng-48. (UCRL-2286)

Equilibrium constants at various temperatures in the range 700 to 900°K have been determined for the vapor-phase hydrolysis of the trichlorides of  $La$ ,  $Pr$ ,  $Nd$ ,  $Sm$ ,  $Gd$ ,  $Tb$ , and  $Am$ . The reactions were studied by a flow method in which mixtures of  $HCl(g)$  and  $H_2O(g)$  were passed over the solid materials mounted on a cantilever-type quartz-fiber balance. The progress of the reaction was determined by observing the weight change of the solid. From the data obtained and an estimate of the  $\Delta C_p$  of the hydrolysis reactions, values were calculated for the heats and entropies of the reactions. In addition, the Madelung constants were calcu-



lated from x-ray crystallographic data for some of the lanthanide and actinide trichlorides and oxychlorides. Crystal energies were obtained from the appropriate equation for the total Coulombic energy and by considering individual repulsive terms for the touching or overlapping ion pairs. Differences in the calculated crystal energies of the oxychlorides and trichlorides were compared to the experimentally determined heats for the vapor-phase hydrolysis of respective lanthanide or actinide trichlorides. Ionization potentials are estimated for several lanthanide elements as a consequence of the crystal-energy calculations. From several of the ionization potentials and from available thermodynamic and crystallographic data an electron affinity is estimated for nitride ion. (auth)

\*773

THE HEAT OF COMBUSTION OF CERIUM. Elmer J. Huber, Jr. and Charles E. Holley, Jr. *J. Am. Chem. Soc.* **75**, 5645-7(1953) Nov. 20.

A precise measurement has been made of the heat of combustion of Ce metal. It was found to be  $7749 \pm 10$  j/g at an  $O_2$  pressure of 25 atm. The heat of formation of  $CeO_2$  at  $25^\circ$  is calculated to be  $-1088.6 \pm 1.4$  kJ/mole. This value differs by 7 to 12% from those found in the literature. (auth)

#### SEPARATION PROCEDURES

\*774

Stanford Research Inst.  
SELECTED LIST OF REFERENCES REVIEWED DURING THE STUDY OF COUNTERCURRENT ION EXCHANGE. TECHNICAL REPORT NO. 8. Nevin K. Hiester and Russell C. Phillips. June 29, 1953. 20p. Contract AT(11-1)-110, Report No. 33. (AECU-2729)

This bibliography includes 216 references arranged alphabetically by authors and categorized as follows: ion exchange, liquid-phase adsorption, distillation, gas absorption, gas-phase adsorption, heat transfer, liquid-liquid extraction, solid-liquid extraction (leaching), and mass transfer. (J.A.G.)

\*775

Stanford Research Inst.  
ION EXCHANGE OF TRACE COMPONENTS IN A COUNTERCURRENT EQUILIBRIUM STAGE CONTACTOR. TECHNICAL REPORT NO. 3. Nevin K. Hiester, Russell C. Phillips, Earl F. Fields, Raymond K. Cohen, and Shirley B. Radding. Apr. 1, 1953. 35p. Contract AT(11-1)-110, Report No. 26. (AECU-2751)

The theory, design, and operation of an intermittent mixer-settler type of resin-solution contactor, as applied to the separation of ionic components, are discussed. The equipment described can be used as a satisfactory intermittent equilibrium-stage contactor for countercurrent ion exchange between resins and solutions. Under trace conditions, the operation of the unit may be accurately predicted by the modified Kremser equation as long as equilibration times are adequate. A photograph of the mixer-settler assembly and an intermittent mixer-settler flow diagram are included. (For preceding report in series see COO-59.) (C.H.)

\*776

Livermore Research Lab., Calif. Research and Development Co.  
CALCULATION OF STAGewise CONTACTING SYSTEMS. J. L. Bloom and P. L. Auer. May 22, 1953. 45p. (MTA-35)

General expressions relating product-stream compositions to the operating conditions of countercurrent stagewise extraction columns are derived by an inductive method, and the conversion of the general equations to ones involving the particular case of constant extraction factor

is demonstrated. For comparison, the derivation of simple column equations by the use of finite difference equations is included. Equations determining the recoveries and separations to be expected from countercurrent stagewise extraction equipment are not readily adaptable to mathematical analysis when variations in operating conditions are considered. The possibility of making simplifying approximations in their use is therefore examined, and, in the cases where approximations are unreasonable, graphical representations of the equations have been prepared and their use demonstrated. (auth)

\*777

Oak Ridge National Lab., Y-12 Area  
FRACTIONAL SEPARATION OF RARE EARTHS BY PRECIPITATION WITH MANDELIC ACID. Boyd Weaver. Issued Dec. 4, 1953. 15p. Contract W-7405-eng-26. (ORNL-1628)

Most of the rare earths may be precipitated from solution by mandelic acid. The process is unusually selective and has the characteristics of precipitation from homogeneous solution. Minimum pH values for precipitation vary markedly from element to element. The rapidity and completeness of precipitation of each element depend on pH, concentration of mandelic acid, temperature, and concentration of rare earth. Fractionation of rare earth mixtures may be continued through a long series by a single addition of mandelic acid, followed only by filtrations and alternate additions of  $NH_4OH$  and  $HCl$ . Application of this process to quantities of rare earth oxides up to 100 g has given fractions greatly enriched in individual rare earths. (auth)

\*778

Oak Ridge National Lab., Y-12 Area  
FRACTIONAL SEPARATION OF RARE EARTHS BY OXALATE PRECIPITATION FROM HOMOGENEOUS SOLUTION. Boyd Weaver. Issued Dec. 4, 1953. 12p. Contract W-7405-eng-26. (ORNL-1629)

A study of the fractional precipitation of oxalates from homogeneous solution has established semiquantitative relationships among most of the rare earths. By fractionation of pairs and multicomponent mixtures of these elements, separation factors have been determined for pairs throughout the series. Samarium has been found to precipitate preferentially to all of the other rare earths, with the lighter elements following in order of decreasing atomic number, while the heavier elements follow Sm in order of increasing atomic number. All of the rare earths precipitate preferentially to Y. The effects of temperature and concentration on separation have been studied. (auth)

779

ION EXCHANGE AS A SEPARATION METHOD. VI. COLUMN STUDIES OF THE RELATIVE EFFICIENCIES OF VARIOUS COMPLEXING AGENTS FOR THE SEPARATION OF LIGHTER RARE EARTHS. S. W. Mayer and E. C. Freiling. *J. Am. Chem. Soc.* **75**, 5647-9(1953) Nov. 20.

Using columns of Dowex-50 cation-exchange resin at  $87^\circ$ , Sm-Eu and Eu-Tb separation factors have been determined for a number of complexing agents under dynamic conditions. A comparison of the separation factors thus obtained yields the following order of selectivity for the complexing agents studied:  $EDTA > lactate = glycolate > malate \geq citrate$ .  $EDTA$  (ethylenediaminetetraacetate) has the disadvantage of low solubility in the pH range most suitable for good separations. (auth)

#### SORPTION PHENOMENA

780

CALCULATIONS OF THE HEAT OF ADSORPTION OF HYDROGEN ON PLATINUM. W. M. H. Sachter. *Rec. trav. chim.* **72**, 897-8(1953) Sept.-Oct. (In English)



The results of recent measurements on the work functions of a pure and a  $H_2$ -covered Pr surface are used to calculate the heat of adsorption of  $H_2$  on Pt. The value obtained is compared with experimental results and with another theoretical value, calculated from Beeck's velocity constant, for the hydrogenation of ethylene on Pt by using a general relation between the velocity constant and the heat of adsorption as given by Beeck. (auth)

781

THE HEATS OF ADSORPTION OF HYDROGEN ON Ni-SiO<sub>2</sub> CATALYSTS. G. C. A. Schuit and N. H. De Boer. *Rec. trav. chim.* 72, 909-30(1953) Sept.-Oct. (In English)

The heats of adsorption of  $H_2$  on several Ni-SiO<sub>2</sub> catalysts were determined from the dependence of the amounts adsorbed on the pressure and the temperature. Three systems were investigated: a sample obtained by reduction of an imperfectly crystallized Ni montmorillonite, a coprecipitate, and an impregnation catalyst. The three systems were found to differ in the total amounts of  $H_2$  adsorbed. The following equation was found to apply for temperatures between 195 and 673°K and pressures from 0.1 to 100 mm Hg.  $RT \ln p(\text{atm}) + T(\mu_T^0 - h_T^0/T) - 2RT \ln \Theta_H/1 - \Theta_H = -24,000 + 14,400 \Theta_H \text{ cal mole}^{-1}$ . In this equation  $(\mu_T^0 - h_T^0)/T$  is the "free energy function" of gaseous  $H_2$ , and  $\Theta_H$  is the fractional coverage by assuming total coverage at 195°K and 1 atm. Heats of adsorption deduced from this equation were found to be 5 kcal mole<sup>-1</sup> lower than those reported for Ni films but higher than others reported for Ni obtained by reduction. The possible causes of these differences are discussed. (auth)

## SPECTROSCOPY

782

American Spectrographic Labs.  
RESEARCH AND INVESTIGATION IN THE SPECTROCHEMICAL ANALYSIS OF MAJOR AS WELL AS MINOR CONSTITUENTS IN NATURAL AND SYNTHETIC SILICATES AND OXIDES. FIRST QUARTERLY PROGRESS REPORT, DECEMBER 1951-FEBRUARY 1952. Charles E. Harvey. 14p. Contract DA-36-039-SC-15441. (ATI-151246)

The spectrochemical analysis of samples of mica is reported. An investigation was made of various excitation conditions to improve the sensitivity of the analyses without loss of reproducibility. Of those tried, a 50- $\mu$ f, 640- $\mu$ h, 50-ohm case proved satisfactory. The reproducibility obtained is tabulated. (J.A.G.)

\*783

Livermore Research Lab., Calif. Research and Development Co.  
AN AUTOMATIC COUNT AND CONTROL SYSTEM FOR A BETA-RAY SPECTROMETER. J. L. Olsen and G. D. O'Kelley. Issued Sept. 1953. 20p. Contract AT(11-1)-74. (MTA-37)

An electromechanical automatic count and control unit for a  $\beta$ -ray spectrometer is described. The count control unit provides for constant count or time limited recording of data and actuates an automatic stepping system which sweeps a well regulated motor generator power supply over 100 increments of focusing magnet current. A 0.1 to 12 amp range, or any desired portion thereof, can be explored in one scanning operation, by use of 0.001 to 0.13 amp per increment. This automatic control is a trouble-free, time-saving apparatus which duplicates with precision the manual control of a  $\beta$ -ray spectrometer. (auth)

784

Naval Research Lab.  
SOME SPECTROSCOPIC STUDIES OF ROTATIONAL ISOMERISM. R. E. Kagarise and L. W. Daasch. Nov. 9, 1953. 21p. (NRL-4248)

Spectroscopic studies of the phenomenon of rotational isomerism in *sym*-dibromotetrafluoroethane ( $CF_2Br-CF_2Br$ ), *sym*-difluorotetrachloroethane ( $CFCl_2-CFCl_2$ ), and oxalyl chloride ( $COCl-COCl$ ) have been performed. On the basis of observations of the Raman spectrum of the liquid and the infrared spectrum of the vapor, liquid, and solid it is concluded that  $CF_2Br-CF_2Br$  exists as two isomeric species. Of these, the *trans* form ( $C_{2h}$ ) is the more stable, while the *gauche* ( $C_2$ ) is probably the higher-energy form. The value of  $\Delta H$  for the reaction *trans* ( $C_{2h}$ )  $\rightarrow$  *gauche* ( $C_2$ ) was found to be 910 cal/mole in the liquid and 840 cal/mole in the vapor state. The behavior of the infrared and Raman spectrum of  $CFCl_2-CFCl_2$  as a function of temperature and upon solidification was anomalous in that no changes in the relative intensities of the spectral lines were observed. In order to explain this unexpected behavior and the observed vibrational spectrum it is postulated that two isomeric species of equal or nearly equal ( $\Delta H \leq 300$  cal/mole) energy exist. Because of the partial fulfillment of the rule of mutual exclusion, one of the isomers is very probably the *trans* form of symmetry  $C_{2h}$ . The infrared spectrum of liquid and solid oxalyl chloride in the 2- to 22- $\mu$  region has been studied. Certain lines present in the spectrum of the liquid disappear completely upon solidification as expected if  $COCl-COCl$  exists as both the *cis* ( $C_{2v}$ ) and *trans* ( $C_{2h}$ ) forms. (auth)

## SYNTHESES

785

National Bureau of Standards  
SYNTHESIS OF  $\alpha$ -D-XYLOSE-1-C<sup>14</sup> AND  $\beta$ -D-LYXOSE-1-C<sup>14</sup>. Horace S. Isbell, Harriet L. Frush, and Nancy B. Holt. Oct. 15, 1953. 13p. (NBS-2836)

A method is outlined for the preparation of  $\alpha$ -D-xylose-1-C<sup>14</sup> and  $\beta$ -D-lyxose-1-C<sup>14</sup> by a cyanohydrin synthesis employing D-threose and labeled cyanide. The method is said to make possible the preparation of these two sugars at reasonable cost. (C.H.)

## TRACER APPLICATIONS

786

Kansas Univ.  
APPLICATION OF RADIOACTIVE TRACERS TO DISTILLATION AND EXTRACTION STUDIES. SUMMARY REPORT FOR THE PERIOD OCTOBER 1, 1948 TO JANUARY 31, 1951. J. O. Maloney, H. E. Hughes, Betty Seay, and Jean Arnold. Oct. 1952. 374p. Contract AT(11-1)-31. (AECU-2732)

A method for counting C<sup>14</sup> in volatile liquids is described and applied to liquid-vapor equilibria studies. The application of C<sup>14</sup> as a tracer in studies of multicomponent distillation was investigated, and data are included from tracer studies of extraction equilibria. (C.H.)

## URANIUM AND URANIUM COMPOUNDS

787

DOUBLE FLUORIDES OF URANIUM HEXAFLUORIDE. H. Martin, A. Albers, and H. P. Dust. Translated from *Z. anorg. u. allgem. Chem.* 265, 128-38(1951). 15p. (AEC-tr-1285)

An abstract of this report appears in *Nuclear Science Abstracts* as NSA 5-6719.

788

PROPERTIES OF THE SULFIDES OF URANIUM  $US_2$ ,  $\alpha$  AND  $\beta$ . Marius Picon and Jean Flahaut. *Compt. rend.* 237, 1160-2(1953) Nov. 9. (In French)

The crystal structure of  $US_2$ ,  $\alpha$  is quadratic with  $a = 10.26\text{\AA}$  and  $c = 6.30\text{\AA}$ . The  $\beta$  form is orthorhombic with  $a = 4.12$ ,  $b = 7.11$ , and  $c = 8.46\text{\AA}$ . The densities were measured



as  $7.60 \pm 0.06$  for  $\alpha$  and  $8.03$  to  $8.07 \pm 0.06$  for the  $\beta$  form. At  $175^\circ$  the magnetic susceptibility of  $US_2$   $\alpha$  is  $3137 \times 10^{-6}$  cgs and of  $US_2$   $\beta$  it is  $3470 \times 10^{-6}$  cgs. The sulfides produce  $U_2S_3$  by dissociation in a vacuum at  $1300^\circ$ . This sulfide can also be produced by reaction of  $US_2$  with  $H_2$  at a slightly lower temperature. All the sulfides are readily attacked by acids and oxidants. (J.S.R.)

## ENGINEERING

### HEAT TRANSFER AND FLUID FLOW

789

Columbia Univ.

TEMPERATURE FLUCTUATIONS IN RESISTANCE HEATING WITH ALTERNATING CURRENT. R. Wayne Houston. June 1953. 33p. DuPont Subcontract AX-294. (CU-3-53-At-dP-Ch.E.)

An attempt has been made to predict the magnitude of surface temperature fluctuations in a-c resistance heating on the basis of two models. Substantial agreement is obtained for  $H_2O$  as a coolant, but divergent results are obtained for air cooling. Both models indicate that such fluctuations can become important for high heat transfer rates, particularly if the dimensions of the heater are small in the direction of any temperature gradient. Temperature fluctuations may be of importance in their effect on the coefficients for various modes of heat transfer. Possible resonance effects are also discussed. (auth)

790

Los Alamos Scientific Lab.

SOME CONSIDERATIONS ON HELMHOLTZ INSTABILITY. Edward Frieman. Sept. 15, 1953. 15p. Contract W-7405-eng-36. (LA-1608)

This report deals mainly with the case of two incompressible fluids of equal densities. Dimensional arguments are given regarding the early and late stages of Helmholtz instability. The second of these arguments is in support of a conjecture that the amplitude eventually grows at a constant rate, of the order of the velocity discontinuity  $2v$ . This conjecture is in agreement with numerical calculations of Rosenhead and Carter, which indicate that the steady-state rate of growth is about  $0.34U$ . It is pointed out that such a steady state will give rise to a "wiping coefficient," as defined by Ingraham and Wheeler, of about  $0.17$ . The character of the mixing in the late stages is discussed, and it is concluded that the mixing will be quite fine and complete. The wavelength for maximum growth is derived by considering the transition from exponential to steady-state growth. By using a result of Carter's version of the Rosenhead calculation, this wavelength is found to be about  $5.2\pi$  times the initial amplitude. Finally, the initial rate of growth is found for the case of compressible fluids. It is concluded that compressibility will increase the instability and will not determine a wavelength of maximum growth. (auth)

791

Livermore Research Lab., Calif. Research and Development Co.

ANALYTICAL SOLUTION OF THE STRESS STATE IN A CYCLIC HEATED ROD. J. E. Mahlmeister. Issued Sept. 1953. 20p. Contract AT(11-1)-74. (LRL-61)

A theoretical analysis of the transient temperatures, thermal stresses, and heat fluxes within a cyclic-heated rod

is presented. The treatment is limited to the theoretical solutions, and no experimental information is given. (auth) 792

THE STATIONARY FLOW OF VERY RAREFIED GASES. P. Clausing. Translated from *Verslag. Gewone Vergader. Afdeel. Natuurk., Ned. Akad. Wetenschap.* 35, 1023-?(1926). 59p. (AEC-tr-1744)

793

INTERFEROMETRIC STUDIES OF SUPERSONIC FLOWS ABOUT TRUNCATED CONES. J. H. Giese and V. E. Bergdolt. *J. Appl. Phys.* 24, 1389-96(1953) Nov.

Fringe shifts on interferograms of flows at  $M = 2.45$  about variously truncated  $15^\circ$  (half-angle) cone cylinders in free flight in a pressurized range were examined for similarity of the flow fields, occurrence of scale effects, and convergence to conical flow. It was found that flows over similar objects with equal tip Reynolds numbers were similar and that convergence to conical flow occurred before the disturbance at the tip had been reflected the second time along characteristics to the body. Density distributions were determined, and a number of comparisons are made with theoretical predictions. (auth)

## MINERALOGY, METALLURGY, AND CERAMICS

794

New York State Coll. of Ceramics, Alfred Univ.

STUDY OF BASIC MECHANISM OF DIFFUSION OF METALS INTO CERAMIC MATERIAL. PROGRESS REPORT NO. 3 FOR THE PERIOD JULY 10, 1953-OCTOBER 10, 1953. Robert C. Turnbull and W. G. Lawrence. 5p. Contract AF18(600)-591. (NP-4979)

The interdiffusion coefficients for Fe into single crystals of magnesia have been measured from  $1060$  to  $1340^\circ C$  and are described by the equation  $D = 9.45 \times 10^{-9} e^{-25,900/RT}$   $cm^2/sec$ . (For preceding period see NP-4735.) (auth)

### CERAMICS AND REFRACTORIES

795

Pennsylvania State Coll. School of Mineral Industries  
REFRACTORY MATERIALS FOR USE IN HIGH TEMPERATURE AREAS OF AIRCRAFT. SUMMARY REPORT NO. 3 (ANNUAL). June 15, 1952. 46p. Contract W33-038 ac 16375(17284). (NP-4971)

796

Massachusetts Inst. of Tech.

STUDY OF METAL-CERAMIC INTERACTIONS AT ELEVATED TEMPERATURES. QUARTERLY PROGRESS REPORT. F. H. Norton, W. D. Kingery, et al. Oct. 1, 1953. 7p. Contract AT(30-1)-1192. (NYO-6290)

Surface tension measurements of  $B_2O_3$  in air and in He after vacuum melting indicate agreement and a positive temperature coefficient of surface tension. With improved atmosphere control, the surface tension of Fe in He has been found to be  $1725$  dyne/cm. Fe-C alloys have been prepared for surface tension and wettability measurements, and samples of vacuum-cast Ni have been obtained for the preparation of metal alloys. (auth)

797

Pennsylvania State Coll.

REFRACTORY MATERIALS FOR USE IN HIGH-TEMPERATURE AREAS OF AIRCRAFT. Norman R. Thielke.



Jan. 1953. 55p. Contract W33-038-ac-16374. (WADC-TR-53-9; AD-9729)

Theoretical approaches to the mechanism of thermal expansion were reviewed, and applications to the alkali halides were examined for clues to the thermal behavior of refractory materials. Inadequate theory and incomplete data precluded any valid generalizations. Crystal structure appeared as an important determiner of expansion behavior. Aluminum titanate bodies matured only above 1260°C; five-hr heating at 1400°C developed moderate strength and low expansivity. Expansion of such bodies to 1000°C approached zero; a rapid rise accompanying decomposition ensued between 1000 and 1400°C. Thermal hysteresis was indicated as a time-consuming effect related to reaction equilibrium. The isostructural nature of Al titanate and pseudobrookite was confirmed, and the expansion anisotropy of the former was investigated. Substitution of equivalent or isomorphous oxides in the Al titanate formula yielded no marked improvement in over-all properties. Addition of numerous high-silica glasses also failed to strengthen the bond of Al titanate bodies without sacrifice of low expansivity. Slip-cast, clay-bonded alumina and beryl turbine nozzle blades failed after 1 to 4 cycles of thermal shock; similar clay-bonded Al titanate blades easily withstood 75 cycles of shock from 885 to 25°C under simulated service conditions. A literature review relative to crystallographic inversions indicated the merit of solid soluble constituents or a restraining glassy envelope as means of control of damaging volume changes during thermal cycles. (auth)

798

North Carolina State Coll.

VIBRATORY COMPACTING OF METAL AND CERAMIC POWDERS. W. C. Bell, R. D. Dillender, H. R. Lominac, L. W. Long, and E. G. Manning. Apr. 1953. 49p. Contract AF-33(616)-73. (WADC-TR-53-193)

The scope of this experimental program covers the packing of three nonplastic powders by the use of vibrations in the low-, medium-, and high-frequency ranges. The results of packing by these methods were compared with packing of similar powders by hydrostatic pressing. The powders selected for this work were pure  $Al_2O_3$ , an  $Al_2O_3$ -Cr cermet, and a TiC-Ni cermet. The types of vibration sources used were: mechanical, electrical-mechanical, pneumatic, magnetostrictive, and exponential horn driver units. The electrical-mechanical and pneumatic systems were found to be the most easily applied ones, and for this reason most of the work has been done with these two types of vibration. Higher densities of the powders have been obtained by vibration than by hydrostatic pressing. The use of plasticizers and binders was eliminated by the use of vibratory forming. The vibratory compaction method is also considerably more rapid than the hydrostatic method. (auth)

## CORROSION

799

Department of Mines and Technical Surveys (Canada)  
INTERGRANULAR CORROSION OF HIGH PURITY ALUMINUM IN DISTILLED WATER AT 100°C AND 150°C. M. J. Lavigne. July 8, 1953. 8p. (ES-11)

Corrosion tests carried out by the author in distilled water at 150°C on some high-purity Al indicated that in some cases the intergranular attack did not occur with high-purity Al in the unannealed condition but always occurred in the annealed condition. Etch-pit analyses of samples which resisted the attack revealed that the orientation of the crystals in the contiguous bands was very similar. Other experiments in water at 150°C suggested that the high-purity Al with a 0.1% Si addition, annealed or unannealed, does not

suffer intergranular attack. A metallographic examination of the tested samples showed that there is a low degree of misfit between the adjacent lattices. The results seem to indicate that metallurgical factors have great bearing on the corrosion resistance of high-purity Al, and when interpreting corrosion results its texture should be considered. The unpredictable behavior of the annealed high-purity Al samples indicates that processing variables other than annealing have a marked influence on the corrosion resistance; e.g., the poor corrosion properties of annealed samples of high-purity Al and the corrosion resistance of all the samples of the Al-Si alloy. (auth)

\*800

North American Aviation, Inc.

CIRCULATION OF LEAD-BISMUTH EUTECTIC AT INTERMEDIATE TEMPERATURES. R. Cygan. Issued Oct. 1, 1953. 22p. Contract AT(11-1)-GEN-8. (NAA-SR-253)

Several Pb-Bi eutectic dynamic systems, using both thermal and forced convection, have been operated for various lengths of time at temperatures up to 850°F. Materials studied were limited to low-C steel and straight chrome steels. In all the cases studied, no evidence of corrosion was found. Circulation stoppage was due to secondary effects rather than corrosion of the container material. Low-C steel appears to be a promising container material for use with Pb-Bi eutectic up to 850°F. (auth)

801

Massachusetts Inst. of Tech.

A FUNDAMENTAL INVESTIGATION OF FRETTING CORROSION. H. H. Uhlig, I. Ming Feng, W. D. Tierney, and A. McClellan. Dec. 1953. 52p. (NACA-TN-3029)

This report summarizes all phases of an investigation of fretting corrosion which has been conducted over a period of several years. The presentation of the information is made in three parts. Part I describes a test machine for measuring fretting damage under controlled experimental conditions. Part II presents data for mild steel fretted against itself. Consideration is given to the effects of humidity, temperature, test duration, atmosphere, relative slip, pressure, and frequency. Part III suggests a mechanism for the fretting process. (auth)

## GEOLOGY AND MINERALOGY

802

Bureau of Mines

MATERIALS SURVEY—BAUXITE. Bureau of Mines and Geological Survey. [1953] 301p. (NP-4954)

A general perspective of the place of bauxite within the domestic economy is provided. The first two chapters discuss the ores of bauxite and the uses of end products. Chapters III to IX, respectively, discuss world reserves, production, and distribution; mining, milling, and processing; and bauxite substitutes, prices and tariff, including a list of the mining firms and the plants in current operation. Chapters X to XII discuss the domestic structure of the industry, its political control, and the controls exercised by the United States government in World War II and subsequently. Chapter XIII is a bibliography. (auth)

803

[Pennsylvania State Coll.]

AN INVESTIGATION OF THE CHEMICAL NATURE OF THE ORGANIC MATTER OF URANIFEROUS SHALES. FIRST ANNUAL REPORT [FOR] JANUARY 1, 1953 TO DECEMBER 31, 1953. C. R. Kinney. Issued Sept. 30, 1953. 20p. Contract AT(30-1)-1442. (NYO-6086)

Progress made toward finding optimum conditions for the conversion of the organic matter of a Chattanooga shale to alkali-soluble oxidation products, thus permitting the



removal of this material from the inorganic components, is reported. Mineral acids precipitated the oxidized organic matter, and the precipitates were found to be radioactive. This strongly suggests that a part of the U at least is combined with the organic matter of this shale. The mineral constituents of the shale, after removal of the organic matter which cements the mineral constituents together, appear to be readily separated by simple physical means. Ozonization of the organic matter of the shale has been found to convert it to water-soluble acids which are not radioactive. At the same time pyrite is oxidized to  $\text{Fe}_2(\text{SO}_4)_3$  which, on precipitation as hydroxide, gives a precipitate which is radioactive. These observations suggest that the greater disintegration of the organic matter with ozone produces water-soluble U salts which are precipitated along with Fe in basic solutions. The residual shale, when heated with  $\text{HNO}_3$ , yields additional radioactive material, but even after this treatment the residue was still found to retain activity. These results suggest that the U of this shale is present in several different chemical combinations. (auth)

804

Minnesota Univ.

PROGRESS REPORT FOR APRIL 1 TO OCTOBER 1, 1953.

John W. Gruner, Abraham Rosenzweig, and Deane K. Smith, Jr. Issued Oct. 1, 1953. 9p. Contract AT-30-1-610.

(RME-3060; Progress Report 8)

Field studies were made on the Colorado Plateau and adjacent areas. New significant observations are recorded. Most important is the observation that U occurs as a "black ore" wherever mining or drilling has reached under deep enough cover to be out of the zone of oxidation. This statement applies to all formations and points to the function of the ever present carbonaceous materials as reducing agents for U. The Chinle formation is considered worthy of more attention than it has received in the past, where not too red in color. It is believed the  $\text{CaCO}_3$  is more important as a criterion to ore finding in formations below the Salt Wash than given credit for. The mineralogical studies of the ores and surrounding rocks are being continued. With regard to the colors of the clays and mudstones, some areas were observed where bleaching in and around deposits is not as clear cut as was formerly believed. The reasons for silicification, lignitization and calcification of tree fossils are being investigated. Laboratory experiments have produced interesting results. They require long periods of time. (auth)

805

Grand Junction Operations Office, AEC

THE URANIUM DEPOSITS OF BIG INDIAN WASH, SAN JUAN COUNTY, UTAH. George P. Dix, Jr. Issued Jan. 1953. 15p. (RME-4022)

Uranium deposits in the Big Indian Wash area crop out along an escarpment which forms the westernmost limit of the wash. The deposits are exposed discontinuously through a distance of 5 miles. Two mineralized horizons are recognized: one, a coarse arkose of the Cutler formation; the other, a lower sandstone in the Chinle formation. The Cutler horizon has been mined since 1948, but the Chinle deposits have been worked only since late 1952. The Chinle horizon is continuous in the area, but the arkosic sandstones of the Cutler are lenticular and discontinuous. The Chinle formation has not been previously recognized in eastern Utah as a favorable host rock. (auth)

806

Division of Raw Materials, AEC

POSSIBILITIES OF URANIUM IN PAKISTAN. Edward K. Judd and Ann Warmington. Nov. 1953. 47p., 1 illus. (RME-4042)

The outlook for uraniferous ores in Pakistan is not encouraging. The chief mineral deposits of the country (some of them of substantial importance) are all of types with which U has never yet been found associated as a primary mineral. A few minor and, as yet, imperfectly known occurrences of Cu-Pb-Zn ores do bear a resemblance to the type of ore deposits that experience has shown to be favored by U. Geological conditions in some parts of Pakistan resemble those of the regions whence most of the U is now coming. Certain other areas expose sandstones and shales lithologically like the formations now yielding large supplies of secondary uraniferous minerals, but in this case a favorable lithology alone offers no reason to expect U unless some adequate and logical original source is known. Scattered data create a strong presumption that, with possible exception of far-west Baluchistan, the only region of Pakistan worth exploring for U lies north of latitude  $32^\circ$ , that is, northern Punjab, nearly the whole of North-West Frontier Province, and the states of Swat, Dir, and Chitral. For that reason, the data presented in Sections IV and V of this report relate almost exclusively to that region. Section IV names the areas in which geological conditions seem most favorable, and Section V names some localities from which favorably mineralized deposits have been reported. No U mineral is mentioned in any publication found in this study. Monazite should be expected in the alluvials along almost any of the major streams of northern Pakistan. Gravels along the Soan River of northern Punjab deserve special scrutiny. Pegmatites are numerous in northern Pakistan. A good possibility for the presence of monazite exists in the sands of numerous streams in Mymensingh and Sylhet districts of East Pakistan. (J.E.D.)

807

Geological Survey

RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN SELECTED AREAS OF THE LOWER YUKON-KUSKOKWIM REGION, ALASKA, 1952. Walter S. West. Oct. 1953. 28p., 2 illus. (TEI-291)

Reconnaissance in the lower Yukon-Kuskokwim region during 1952 consisted of an examination for radioactivity of a zeunerite occurrence in the Russian Mountains and molybdenite occurrences in the Marshall area and in the southern Kaiyuh Mountains. Zeunerite, a hydrous Cu-U arsenate, was identified in a concentrate of As-Cu vein material which was collected in the upper tunnel of the Konechney prospect in the Russian Mountains in 1944. Although the underground workings were not accessible in 1952, a trace amount of zeunerite was found in a sample from the ore dump of this same tunnel. No other occurrence of U minerals were found. The oxidizing and highly acid environment of the ore dumps and bedrock outcrops in the Russian Mountains could account for the scarcity of secondary U minerals and the absence of primary U minerals near the surface. If so, the trace amounts of zeunerite that have been found may indicate that larger amounts of secondary U minerals occur at greater depths and possibly grade downward into significant deposits of primary U minerals. The maximum equivalent U content of the samples collected during 1952 in this area is 0.004%. No U deposits of commercial importance were found in the Marshall and southern Kaiyuh Mountains area. Samples collected in the Marshall area contain 0.001% or less equivalent U. The vein material at the McLead molybdenite prospect in the southern Kaiyuh Mountains shows less than 0.001% equivalent U, and the rhyolite porphyry country rock contains 0.003% equivalent U. (auth)

808

Geological Survey

THE ASSOCIATION OF URANIUM AND OTHER METALS



WITH CRUDE OILS, ASPHALTS, AND PETROLIFEROUS ROCKS. R. L. Erickson, A. T. Myers, and C. A. Horr. Dec. 1952. 33p. (TEM-513)

Uranium analyses and semiquantitative spectrographic analyses of the ash of crude oils, natural asphalts, and oils extracted from petroliferous rocks indicate that U and other metals, including V, Ni, Cu, Co, Mo, Pb, Cr, Mn, and As, are consistently present—sometimes in unusually high concentrations—in this type of organic matter. The U content of the ash of these samples ranged from less than 0.001% to more than 10%; the U content of the total oil or asphalt ranged from less than 0.001 to 32,410 ppm (3.24%). It seems probable that these metals occur as metallo-organic compounds and are concentrated in the heavy asphaltic portion of petroleum. The high concentration of unusual elements in the ash of the analyzed samples suggests that these elements were concentrated by some agency connected with the actual formation of oil and therefore have a genetic relationship with the origin of oil and the petroleum source beds. The results of this investigation also suggest that natural asphalts and petroliferous rocks may represent the source materials for the U and other metals in some U deposits. (A.G.W.)

#### METALS AND METALLURGY

809

Battelle Memorial Inst.  
SHORT-TIME CREEP PROPERTIES OF STRUCTURAL SHEET MATERIALS FOR AIRCRAFT AND MISSILES. J. A. VanEcho, L. C. Page, W. F. Simmons, and H. C. Cross. Aug. 1952. Contract AF 33(038)-8743. (AF-TR-6731(pt.1))

The short-time creep strengths of several aircraft structural sheet materials at times up to approximately 100 min were determined. The materials tested included two Mg alloys, three Al alloys, four steels, and two high-temperature alloys. Each group of materials was tested over the useful temperature range for the material in that group. The testing procedure was to load the specimen cold, heat to the desired temperature by resistance heating, and hold at the test temperature until the test was completed. A slide-wire extensometer was used, and the total extension of the specimen was recorded on a high-speed recorder. The data are presented as time-deformation curves, design curves, and curves comparing the materials after one, ten, and sixty min of loading. Among the light alloys, 24 S-T had the highest strength at all test temperatures. Steels containing Ti and B had high strength but were very brittle. The high-temperature alloy L-605 in the hot-rolled condition had very good properties between 1200 and 2000°F. (auth)

810

Battelle Memorial Inst.  
PROGRESS REPORT ON ZIRCONIUM PILOT PLANT RESEARCH AND DEVELOPMENT. O. E. Accountius, D. G. Black, C. E. Dryden, B. C. Finney, B. A. Gruber, W. G. Jurevic, R. McDonough, L. F. Plock, D. J. Stephan, S. A. Woodruff, and I. E. Campbell. Sept. 20, 1951. 16p. Contract AT(30-1)-771B. (BMI-530)

The progress of the work on the cyclical-flow iodide Zr pilot plant and the status of the plant operations are briefly outlined. (J.E.D.)

\*811

Battelle Memorial Inst.  
CREEP STRENGTH OF BORAL SHEET AT 200, 400, AND 600 F. H. A. Saller, J. A. VanEcho, and J. T. Stacy. Nov. 23, 1953. 14p. Contract W-7405-eng-92. (BMI-883)

The creep-rupture properties of 2 samples of Boral sheet (35 wt. % B<sub>4</sub>C and 65 wt. % 2S Al core clad with 2S Al) were

determined at 200, 400, and 600°F for rupture times up to 500 hr. Some variation in strength was noted between the 2 samples. Directionality variation was small, especially at the 2 higher temperatures. Results of these tests indicating the stress characteristics are given. (auth)

\*812

Ames Lab.  
PREPARATION OF VANADIUM METAL. John R. Long and Harley A. Wilhelm. Aug. 1951. 62p. Contract W-7405-eng-82. (ISC-244)

Vanadium metal in the massive form was prepared by Ca reductions of V<sub>2</sub>O<sub>5</sub>, V<sub>2</sub>O<sub>3</sub>, VF<sub>3</sub>, and V<sub>2</sub>S<sub>3</sub>. The exothermic chemical reduction was carried out in closed Fe bombs lined with dolomitic oxide refractory. A secondary reaction between a S booster reagent and excess reductant furnished auxiliary heat and gave a product capable of lowering the melting point of the slag. This allowed better agglomeration of the metallic phase. On the scale investigated, metal thus reduced collected in a solid regulus weighing about 70 g. Some of the metal produced was ductile and could be cold rolled to thin sheets. From V<sub>2</sub>O<sub>5</sub>, available commercially in the chemically pure and technical-grade forms, other V compounds utilized in the reduction process were prepared. V<sub>2</sub>O<sub>5</sub> was reduced to V<sub>2</sub>O<sub>3</sub> with H<sub>2</sub> at 700°C. VF<sub>3</sub> was prepared by passing anhydrous HF over V<sub>2</sub>O<sub>5</sub> at room temperature, followed by drying of the hydrated trifluoride at 300°C in an atmosphere of HF. V<sub>2</sub>O<sub>3</sub> was converted to V<sub>2</sub>S<sub>3</sub> by reaction with H<sub>2</sub>S at 800°C. (auth)

\*813

Ames Lab.  
STABILITY OF ZIRCONIUM OXIDE IN GRAPHITE SURROUNDINGS. D. R. Wilder and E. S. Fitzsimmons. Sept. 1, 1953. 15p. (ISC-403)

Zirconium oxide specimens which have been fired at high temperatures in graphite enclosures are known to fail mechanically upon oxidation. A review of the literature failed to completely explain such failure. Possible causes of failure, arising both from internal and external influences, are discussed. Experimental investigation established the presence of Zr carbide in all specimens where failure later occurred. Compressive strengths were measured both before and after oxidation and are discussed. Limitations and recommendations for graphite firing of Zr oxide are given. (auth)

814

National Bureau of Standards  
ELECTRODEPOSITION OF TITANIUM. [QUARTERLY PROGRESS REPORT FOR] JULY 1-SEPTEMBER 30, 1953. J. M. Sherfey and A. Brenner. Oct. 1, 1953. 7p. (NBS-2816)

The production of NaTiCl<sub>4</sub> in pound quantities and the successful electrodeposition of Ti from a melt of NaTiCl<sub>4</sub> in LiCl-KCl eutectic are reported. Preliminary studies of methods of separating anode and cathode reactions during molten salt electrolysis indicate glass diaphragms are satisfactory for the separation. (See also NBS-2861.) (C.H.)

815

National Bureau of Standards  
ELECTRODEPOSITION OF TITANIUM. [QUARTERLY PROGRESS REPORT FOR] JULY 1-SEPTEMBER 30, 1953. W. Reid, J. Bish, and A. Brenner. Oct. 1, 1953. 8p. (NBS-2861)

Progress is reported in an investigation of methods for the electrodeposition of Ti. An investigation of organo-Ti compounds was continued, and a method is described for the preparation of phenyl Ti triisopropylate. Preliminary studies, in which the electrodeposition of Zr was studied, were continued, and the preparation of Zr borohydride and the



electrodeposition of Zr-Al alloys from hydride baths are reported. (See also NBS-2816.) (C.H.)

816

NEPA Div., Fairchild Engine and Airplane Corp.  
PRELIMINARY INVESTIGATION CONCERNING THE  
FABRICATION OF TUNGSTEN SHAPES AT INTERMEDIATE  
TEMPERATURES. F. K. Lampson and H. R. Stephan.  
Oct. 10, 1950. 8p. (NEPA-IC-50-11-36)

817

NEPA Div., Fairchild Engine and Airplane Corp.  
SELECTED PROPERTIES OF WROUGHT ALUMINUM  
SHEET. H. A. Dorfman. Feb. 20, 1951. 24p. (NEPA-  
IC-51-3-20)

818

Brush Labs. Co.  
DEVELOPMENT OF TITANIUM ALLOY POWDER PRODUC-  
TION. FINAL REPORT [FOR] AUGUST 15, 1951-AUGUST  
28, 1953. G. F. Davies. 40p. Contract DA-33-019-ORD-  
328. (NP-4981)

Methods for the preparation and evaluation of various Ti-alloy powder scraps are described. Because of preliminary difficulties and delays in procuring satisfactory alloy Ti scrap, Ti sponge as a usable high-purity control material was substituted in the early development of methods of producing powder. The reasonable consistency of Ti sponge aided in proving the processes. The result of the program was to evolve: an attritioning method for producing from alloy scrap powders of usable metallurgical grade having a minimum of added impurities; a method for reducing scrap alloy turnings of reasonable purity to powder with a minimum of added impurities by mechanical mutilation and the application of a Hg technique; and a method for the reduction of massive Ti alloy scrap to powder by means of consolidating the irregular-shaped scrap alloy into a billet and then reducing the billet by a mechanical-cutting technique under Hg to turnings. The Hg is then removed and the turnings in turn reduced by mutilation to powder. (For preceding report in series see NP-4676.) (auth)

819

Columbia Univ., School of Engineering  
THE MECHANISM OF METALLOGRAPHIC ETCHING.  
QUARTERLY PROGRESS REPORT NO. 3. George L. Kehl  
and Max Metlay. May 31, 1952. 35p. Contract AT-30-1-  
1006, Scope 1. (NYO-832)

Closed-circuit potential measurements were made on two-phase brass (80% Cu, 40% Zn) in a variety of reagents. A detailed discussion of the apparatus and technique is presented. Electron diffraction studies were made to determine the effect of several etching reagents on single crystals of  $\alpha$  and  $\beta$  brass. (For preceding period see NYO-831.) (J.S.R.)

820

Royal Aircraft Establishment, Farnborough, Hants (England)  
TORSIONAL STRENGTH OF BARS IN STEEL AND ALUMIN-  
IUM, MAGNESIUM AND COPPER ALLOYS. E. L. Ripley,  
A. J. Beard, and B. A. J. McCarthy. July 1953. 39p.  
(RAE-TN-STRUCT-119)

Simple empirical relationships between the torsional and tensile strengths of solid and hollow bars are derived from tests on steel and Al, Mg, and Cu alloys. Both proof and ultimate conditions of failure are considered. The relationships are used to present design data on the torsional strength of solid and hollow bars. (auth)

821

Royal Aircraft Establishment, Farnborough, Hants (England)  
SHEAR STRENGTH OF PINS IN STEEL AND ALUMINIUM,  
MAGNESIUM AND COPPER ALLOYS. E. L. Ripley and  
A. J. Beard. July 1953. 28p. (RAE-TN-STRUCT-120)

Simple empirical relationships between the ultimate shear

strength and ultimate tensile strength of cylindrical pins are derived from tests on steel and Al-, Mg-, and Cu-alloy bars. The relationships are used to present design data on the shear strength of pins. (auth)

822

General Electric Research Lab.  
FUNDAMENTAL RESEARCH IN PHYSICAL METALLURGY.  
NINETEENTH QUARTERLY REPORT. (PROGRESS REPORT  
NO. 36). J. H. Hollomon and D. Turnbull. Oct. 5, 1953. 7p.  
Contract W-31-109-Eng-52. (SO-2030; RL-979)

The self-diffusion coefficient,  $D_{Pb}$ , of Pb in an infinitely dilute solution of Pb in Ag is described by the equation  $D_{Pb} = 0.39 \exp(-39,200/RT) \text{ cm}^2 \text{ sec}^{-1}$ . It is concluded that, in the temperature range of the measurements,  $D_{Pb}$  is 10 to 14 times greater than the self-diffusion coefficient of the Ag. The excess entropy,  $\Delta S$ , of a supersaturated Au-Ni solid solution (48 at. % Ni) over the entropy of the pure elements is 0.5 e.u. at 300°K. (For preceding period see SO-2029.) (auth)

823

Research Foundation, Ohio State Univ.  
NICKEL-MAGNESIA CERMET COATINGS. Earle T.  
Montgomery and Jack A. Lytle. June 1952. 16p. Contract  
AF33-(616)-3. (WADC-TR-52-166)

824

Research Foundation, Ohio State Univ.  
EXPLORATORY STUDY OF NICKEL-MAGNESIA CERMETS.  
Earle T. Montgomery and Paul E. Rempes, Jr. Apr. 1953.  
11p. Contract AF33(616)-3. (WADC-TR-53-164)

The combination of Ni and magnesia has already been developed into a promising refractory coating material for metals. For this purpose the cermet is powdered and flame-sprayed. This report covers an exploratory study of the possibilities of processing these two components in the form of a cermet solid body as a potential high-temperature material. (auth)

825

Battelle Memorial Inst.  
CHEMICAL SURFACE TREATMENT OF TITANIUM. IN-  
TERIM TECHNICAL REPORT. H. A. Pray, P. D. Miller,  
and Richard A. Jefferys. Oct. 30, 1953. 33p. Contract  
DA-33-019-ORD-215. (WAL-401/45-215)

The study of various chemical surface treatments of Ti has resulted in three chemical baths capable of coating Ti and its alloys by simple immersion of the metal. The latest development centered about a fluoride-phosphate bath that can operate at room temperature and coat in a 1- to 2-min. immersion. Additional work has been done to establish optimum bath composition and operating conditions for the three immersion baths. Wire-drawing evaluations have shown that by the use of the room-temperature fluoride-phosphate immersion coating, commercial Ti-75A can be continuously cold drawn to a total reduction of 94% without an intermediate anneal. Such results are quite promising and indicate that the immersion-coating process would improve the present commercial methods of drawing Ti. (auth)

826

ON THE THEORY OF LIQUID ALLOYS. (VAPOUR-  
PRESSURES OF METALS IV). A. Schneider and H. Schmid.  
Translated from Z. Elektrochem. 48, 640-6(1942). 9p.  
(AERE-Trans-11/3/5/354)

The results of the thermochemical investigation of binary liquid alloys of Zn and Cd with Cu, Ag, and Au, are discussed in connection with the present views regarding the structure of alloys and the state of concentrated mixtures. At the same time an attempt is made to describe the forces of attraction of influencing factors, independent of size and effect. (auth)

827

MECHANISM OF ARTIFICIAL AGING OF Al-Cu-Mg ALLOY.



Yu. A. Bagaryatskii. Doklady Akad. Nauk S.S.S.R. 87, 397-400(1952) Nov. 21. (In Russian) (cf. NSA 2-2310)

The results of x-ray investigation of aging processes in Al-Cu-Mg alloy is discussed. The alloy had equal atomic concentration of Cu and Mg (3.0% Cu and 1.15% Mg by weight) and was quenched at 490°. Pictures obtained in an x-ray goniometer are presented. (J.S.R.)

828 COMPOSITION VERSUS HEAT RESISTANCE DIAGRAM OF THE Ni-Al SYSTEM. I. I. Kornilov, R. S. Mints, and S. D. Onoprienko. Doklady Akad. Nauk S.S.S.R. 88, 683-5(1953) Feb. 1. (In Russian)

The dependence of heat resistance on the composition of Ni-Al alloys was studied in alloys containing up to 30% Al by weight. It was established that the heat resistance of solid solutions of Al in Ni increases with increase in Al concentration and reaches its maximum in the region of complete saturation of solid solutions. The alloy corresponding to  $\text{Ni}_3\text{Al}$  is characterized by the lowest heat resistance. Solid solutions based on  $\text{Ni}_3\text{Al}$ , but rich in Ni or Al, have a heat resistance higher than that of  $\text{Ni}_3\text{Al}$ . The diagram of composition vs. heat resistance permits the determination of the physico-chemical nature and boundaries of the phase areas on the Ni-Al constitution diagram. (J.S.R.)

## PHYSICS

829 Washington Square Coll. of Arts and Science, New York Univ. DIFFRACTION THEORY. A CRITIQUE OF SOME RECENT DEVELOPMENTS. C. J. Bouwkamp. Apr. 1953. 96p. Contract AF-19(122)42. (AD-14317; Research Report EM-50)

A number of recent developments in the theory of diffraction of electromagnetic waves, particularly those dealing with apertures in plane conducting screens, are reviewed. The subjects treated include modifications of Kirchhoff's theory, the theory of small apertures, Babinet's principle for plane obstacles, variational principles, and singularities at sharp edges. For completeness, a discussion from an alternative viewpoint of the problem of diffraction by an aperture has been included. (auth)

830 Brookhaven National Lab. THE MAGNETIC SUSCEPTIBILITIES OF  $\text{K}_2\text{MoCl}_6$  AND  $\text{RuCl}_3$ . Charles Epstein and Norman Elliott. [1953?] 7p. (BNL-1621)

Magnetic susceptibilities of  $\text{K}_2\text{MoCl}_6$  and  $\text{RuCl}_3$  were measured in the temperature range 76 to 297°K. Curie's law is obeyed by both salts. The magnetic moments 3.83 $\beta$  and 2.07 $\beta$  are calculated for the ions  $\text{Mo}^{+3}$  and  $\text{Ru}^{+3}$ , respectively. (auth)

831 Commissariat à l'Énergie Atomique (France) RÉPERTOIRE ANALYTIQUE A L'USAGE DES PHYSICIENS NUCLÉAIRES. [PART] I. [ANALYTICAL REPERTORY FOR THE USE OF NUCLEAR PHYSICISTS]. (PUBLICATIONS ISSUED FROM JANUARY 1, 1950 TO JUNE 30, 1951). André Berthelot, ed. [nd] 382p. (CEA-120)

(For a bibliography of reports issued from July 1, 1951, to Dec. 31, 1952, see CEA-184.) (J.S.R.)

832 Commissariat à l'Énergie Atomique (France) RÉPERTOIRE ANALYTIQUE A L'USAGE DES PHYSICIENS NUCLÉAIRES. [PART] II. [ANALYTICAL REPERTORY

FOR THE USE OF NUCLEAR PHYSICISTS]. (PUBLICATIONS ISSUED FROM JULY 1, 1951 TO DECEMBER 31, 1952). André Berthelot, ed. [nd] 382p. (CEA-184)

A bibliography of publications on nuclear physics, issued by the French Atomic Energy Commission for the period July 1, 1951, to Dec. 31, 1952, is presented. Author and subject indexes are included. (For a bibliography of reports issued from Jan. 1, 1950, to June 30, 1951, see CEA-120.) (K.S.)

833 Lewis Flight Propulsion Lab., NACA EFFECTIVE THERMAL CONDUCTIVITIES OF MAGNESIUM OXIDE, STAINLESS STEEL, AND URANIUM OXIDE POWDERS IN VARIOUS GASES. C. S. Eian and R. G. Deissler. Oct. 29, 1953. 18p. (NACA-RM-E53G03)

As a part of a general investigation of the effective thermal conductivities of powders, tests were conducted to determine the conductivity of  $\text{MgO}$ , stainless steel, and U oxide powders in various gases at temperatures between 120 and 1455°F. Fair agreement was obtained between conductivities calculated from experimental data for fine  $\text{MgO}$  and stainless steel powders and those calculated from a simplified analysis from a previous investigation, although the experimental values are somewhat higher. Runs were also made to determine the effect of gas pressure on effective thermal conductivity. (NACA)

834 National Bureau of Standards COMPRESSIBILITY, DENSITY, ENTHALPY, ENTROPY, FREE ENERGY, SPECIFIC HEAT, VISCOSITY, AND THERMAL CONDUCTIVITY OF STEAM. Lilla Fano, John H. Hubbell, and Charles W. Beckett. June 1, 1953. 60p. (NBS-2535)

835 Naval Medical Research Inst., Bethesda METEOROLOGICAL DATA ENIWETOK ATOLL. R. Harold Draeger and Richard H. Lee. May 18, 1953. 22p. (NM-006-012.01; Memo Report 53-8)

A meteorological station was established on Japtan Island of the Pacific Proving Grounds in December 1949 for the purpose of collecting data relevant to the design of animal exposure containers to be used in biological field tests of Atomic Weapons. The measurements included air temperatures above land, relative humidity, direction and velocity of wind, soil temperatures, and solar heat load. In addition, surface temperatures of selected materials exposed in the open to direct solar radiation were measured. (auth)

836 Surface Chemistry Lab., Lehigh Univ. HETEROGENEITY OF SURFACES. TECHNICAL REPORT NUMBER 5, JUNE 1, 1952 TO MAY 31, 1953. IMMERSION CALORIMETRY AND ADSORPTION STUDIES: HYDROPHOBIC AND HYDROPHILIC SURFACES AND THE SORPTION OF WATER VAPOR BY OXIDE COATED METALS. A. C. Zettlemoyer, J. J. Chessick, F. H. Healey, and Y[ung-Fang] Yu. 57p. Contract N8onr-74300. (NP-4780)

A heat-of-immersion calorimeter which employs a thermistor as the temperature sensing element was constructed. It is used to provide data to support absorption measurements in studying the heterogeneity of surfaces. Heats of immersion in water were obtained for asbestos, rutile, Graphon, and  $\text{SiO}_2$ . Absolute entropies of water adsorbed on asbestos were calculated. The hydrous nature, molecular thickness, porosity, and stability of oxide films on Mo, Ni, and steel were investigated by adsorption and calorimetric measurements. Adsorption isotherms and heats of immersion were measured for the Graphon-water system. (J.S.R.)



837

Laboratory for Insulation Research, Mass. Inst. of Tech.  
EFFECT OF A TWO-DIMENSIONAL PRESSURE ON THE  
CURIE POINT OF BARIUM TITANATE. TECHNICAL RE-  
PORT NO. 74. P. W. Forsbergh, Jr. Oct. 1953. 20p.  
Contracts N5ori-07801, NR-074-041, and N5ori-07858.  
(NP-4956)

By hydraulic means, a single crystal of  $\text{BaTiO}_3$  in the shape of a flat circular disk was subjected to a pressure exerted on its edges and not on its faces. A very slight pressure removed all domains that were not normal to the disk. The stress system then consisted of equal pressures on the 2 axes and no pressure on the c axis. The transition temperature increased with the square of the 2-dimensional pressure, while, according to Merz, a hydrostatic pressure produces a linear drop. By using Devonshire's expansion for the free energy and the appropriate Legendre transformation, the free energy, depending on polarization and pressure, was obtained for both 2-dimensional and hydrostatic stress systems. This yielded a purely linear-pressure dependence, and it was therefore necessary to supplement Devonshire's expansion with higher terms in order to obtain a quadratic effect. An evaluation is made of the effect of pressure on the transition temperature itself when higher terms are included, and the effect on the Curie-Weiss temperature  $T_0$  was determined. For both 2-dimensional and hydrostatic pressures, the linear part of the shift of the Curie-Weiss temperature was found to depend only on the lower terms in the free energy and provide 2 independent relations for determining the 2 g coefficients. The quadratic shift of the Curie-Weiss temperature depended on the higher terms with which Devonshire's expansion was supplemented, and a reasonable interpretation of these higher terms gave an upward direction to the quadratic shift of the Curie-Weiss temperature. (auth)

838

New York Univ.  
FLUORESCENCE AND CONDUCTIVITY PHENOMENA.  
PROGRESS REPORT NO. 2 FOR MAY, JUNE AND JULY.  
Hartmut Kallmann. Oct. 1953. 74p. Contract DA 36-039 sc-42626. (NP-4968)

A summary of experiments on the fluorescence induced by  $\gamma$  radiation is presented. Graphs describing the fluorescence occurring with various solutes when two solvents are mixed together in various ratios are given. Two types of curves are apparent. One occurs when a solvent which has a strong fluorescence produced in it by  $\gamma$  radiation is mixed with a solute with poor fluorescent characteristics. The good solvent is not affected unless large amounts of the poor solvent are added. The other type of curve is of an inverse shape. Small amounts of the poor solvent will affect the good solvent. Alternating current conductivity measurements were made on six  $\text{ZnCdS}$  powders, and the results were graphed. The saturation effects in a photomultiplier were tested. The tube shows no noticeable effect up to output voltages of approximately 5 volts. (For preceding period see NP-4931.) (J.S.R.)

839

THE KINETICS OF ABSORPTION. M. Kh. Kishinevskii and A. V. Pamfilov. Translated from *Zhur. Priklad. Khim.* 22, 1173-82(1949). 9p. (AERE-Trans-11/3/5/343)

A theory of absorption processes is developed on the principle that the substance is transported by convective diffusion in accordance with which the flow of substances is defined by an equation based on the mean linear velocity of movement of the molecules. A general equation of absorption kinetics is presented, and formulas are deduced for systems with high turbulence in the reacting

phases. The first formula refers to irreversible reactions of the second order, whereas the second is not limited by the order of the reaction. The differing influence of the partial pressure of the gas and of the concentration of the absorbent upon the rate of one and the same absorption process, as dependent upon the hydrodynamical conditions under which the given process is carried on, is shown. (C.H.)

840

IONIZATION AND FRAGMENTATION OF MOLECULES BY BOMBARDMENT WITH ATOMIC IONS. E. Lindholm. *Proc. Phys. Soc. (London)* A66, 1068-70(1953). Nov.

A mass-spectrometric analysis was made of the collision products resulting when various atomic ions were sent into  $\text{H}_2\text{S}$  gas. In a table of results information is presented on the charge exchange, and the mass spectrum of  $\text{H}_2\text{S}$  for the ions is compared with that obtained by electron bombardment. (L.M.T.)

841

ON THE DIFFUSION OF DECAYING PARTICLES IN A RADIAL ELECTRIC FIELD. Julian Keilson. *J. Appl. Phys.* 24, 1397-1400(1953) Nov.

The diffusion of charged particles in the presence of a radial inverse-square electric field is difficult to treat in any general manner. It is possible, however, to treat steady-state radially symmetric flow in such a field. There may then be deduced, from the radial distributions obtained, a function,  $\gamma$ , which provides an important description of steady-state flow from a point source in the radial field. The important point is made that the function  $\gamma$  obeys the differential equation adjoint to that describing time-independent diffusion in the given field. The physical problem treated is of specific interest to transistor theory, but it is hoped that some of the techniques used in treating the problem are of more general interest. (auth)

## COSMIC RADIATION

842

IONIZATION SPECTRUM OF COSMIC-RAY PARTICLES IN THE STRATOSPHERE. N. L. Grigorov, I. D. Rapoport, and G. P. Shipulo. Translated from *Doklady Akad. Nauk S.S.S.R.* 91, 491-4(1953). 4p. (NSF-tr-123)

An abstract of this report appears in *Nuclear Science Abstracts* as NSA 7-6516.

843

GENERATION OF FAST DEUTERONS IN COSMIC RAYS. A. Alikhanyan and G. Marikeyan. *Doklady Akad. Nauk S.S.S.R.* 87, 191-4(1952) Nov. 11. (In Russian)

A detailed investigation of a mass spectrum in the field of particles with masses exceeding the proton mass was made by means of a mass spectrometer with a field of 14,000 gauss. Deuterons were clearly detected. (J.S.R.)

844

INVESTIGATION OF THE COMPOSITION OF COSMIC RAYS AT 1,000 METERS ABOVE SEA LEVEL. N. M. Kochoryan, G. S. Saakyan, M. T. Ayvazyan, Z. A. Kirakosyan, and S. D. Kaytmazov. *Zhur. Eksptl'. i Teoret. Fiz.* 23, 532-42(1952) Nov. (In Russian)

The results of measurements made at 1000 m are described. It is shown that the number of  $\pi$ -mesons within a given interval is 5% less than that of  $\mu$ -mesons. The numerical data of the observations are tabulated. (J.S.R.)

845

GENERATION OF STAR-FORMING PARTICLES IN DENSE SUBSTANCE AT ALTITUDE OF 25 KILOMETERS. Zh. S. Takibaev. *Zhur. Eksptl'. i Teoret. Fiz.* 23, 543-51(1952) Nov. (In Russian)

Photographic plates were exposed at 25 km under various thicknesses of absorbing Pb. The events were analyzed.

The possibility of transitory effects between "stars" and single traces of heavy particles was discussed. (J.S.R.)

#### CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

846

**THEORY OF CRYSTAL PLASTICITY.** Albert Kochenförfer. Translated by Margaret V. Colven from *Z. Physik* 108, 244-64(1938). 21p. (AEC-tr-1747)

A theory of plastic deformation has been developed, of which the following assumptions are the basis: Displacements occur on the edges of ideal mosaic blocks, from which a real crystal exists, with an external shearing stress due to the stress inhomogeneities arising from the effect of thermal fluctuations. The threshold energy for a purely thermal formation amounts to about 50,000 cal for  $N = 6.06 \times 10^{23}$  displacements. From the effect of external shearing stress a displacement creeps through the mosaic block to the other edge on which it is supported, until it is dissolved also on account of the stress inhomogeneity and the thermal fluctuations. The threshold energy amounts to about 0.9 times that of the formation threshold energy. The displacement produces an internal stress field  $\tau$ , which counteracts the external field  $\sigma$  and whose effect is reduced with regard to the new formation of displacements;  $\tau$  produces the hardening arising during the deformation. The dissolution of a displacement thereby reduces  $\tau$ , and the effect of dissolution is thus designated as loosening. The equilibrium between hardening and loosening, dependent on the temperature and slip velocity, determine the path of a hardening curve under given test conditions. The equations were integrated under conditions of constant slip velocity and the path of the hardening curve at more steady slip velocity with the temperature (temperature dependence) as well as at more steady temperature with the slip velocity (velocity dependence) was proven for the existing test conditions. The agreement is very good for the critical shearing stress as well as hardening. (auth)

847

**CRYSTAL STRUCTURE AND NUCLEAR DIRECTIONAL CORRELATION. I.  $Pb^{204}$ .** H. Frauenfelder, J. S. Lawson, Jr., W. Jentschke, and G. DePasquali. *Phys. Rev.* 92, 513-4(1953) Oct. 15.

The nuclear directional correlation for  $Pb^{204}$  has been studied by measuring anisotropies in  $Pb-Tl$  substitutional alloy. This alloy displays f. c. c., b. c. c., and h. c. p. structure for various compositions and temperatures. It is concluded that the interaction between the nucleus and its surroundings is small in the case of the b. c. c.-lattice. Anomalies in the anisotropies of the h. c. p. and f. c. c. structures are not explained. (K.S.)

#### ELECTRICAL DISCHARGE

848

**CONDITIONS FOR THE EXISTENCE OF EQUILIBRIAL ENERGY DISTRIBUTION OF ATOMS IN A DISCHARGE IN CESIUM VAPORS.** A. M. Shukhtin. *Vestnik Leningrad. Univ.* 12, 81-5(1952) Dec. (In Russian)

It was concluded from an analysis of the results of electrical discharge in Cs vapor that the concentration of Cs atoms, even in the first excited level, cannot attain equilibrium values in the interval investigated of discharge currents and vapor tension. (J.S.R.)

#### ELECTRONS

849

**A COLLECTIVE DESCRIPTION OF ELECTRON INTERACTIONS: III. COULOMB INTERACTIONS IN A DEGEN-**

**ERATE ELECTRON GAS.** David Bohm and David Pines. *Phys. Rev.* 92, 609-25(1953) Nov. 1.

The behavior of the electrons in a dense electron gas is analyzed quantum mechanically by a series of canonical transformations. The usual Hamiltonian corresponding to a system of individual electrons with Coulomb interactions is first re-expressed in such a way that the long-range part of the Coulomb interactions between the electrons is described in terms of collective fields representing organized "plasma" oscillation of the system as a whole. The Hamiltonian then describes these collective fields plus a set of individual electrons which interact with the collective fields and with one another via short-range screened Coulomb interactions. There is, in addition, a set of subsidiary conditions on the system wave function which relate the field and particle variables. The field-particle interaction is eliminated to a high degree of approximation by a further canonical transformation to a new representation in which the Hamiltonian describes independent collective fields, with  $n'$  degrees of freedom, plus the system of electrons interacting via screened Coulomb forces with a range of the order of the interelectronic distance. The new subsidiary conditions act only on the electronic wave functions; they strongly inhibit long wavelength electronic density fluctuations and act to reduce the number of individual electronic degrees of freedom by  $n'$ . The general properties of this system are discussed, and the methods and results obtained are related to the classical density fluctuation approach and Tomonaga's one-dimensional treatment of the degenerate Fermi gas. (auth)

850

**A COLLECTIVE DESCRIPTION OF ELECTRON INTERACTIONS: IV. ELECTRON INTERACTION IN METALS.** David Pines. *Phys. Rev.* 92, 626-36(1953) Nov. 1.

The effects of the Coulomb interaction between free electrons in an electron gas are considered for a variety of phenomena. The analysis is based on the collective description, which describes the long-range correlations in electronic positions (due to the Coulomb force) in terms of the collective oscillations of the system as a whole. It is shown that an independent electron model should provide a good description of the electrons in a metal in many cases of interest. The ground-state energy of the free-electron gas is determined, and an estimate of the correlation energy is obtained, with results in good agreement with those of Wigner. The exchange energy is shown to be greatly reduced by the long-range correlations, so that its effect on the level density and the specific heat is comparatively slight, leading to an electronic specific heat for Na which is approximately 80% of the free-electron value. The possible ferromagnetism of a free-electron gas is investigated, and it is found that the long-range Coulomb correlations are such that a free-electron gas will never become ferromagnetic (no matter how low the density). The excitation of the collective oscillations by a fast charged particle is studied, and the semiclassical results obtained by Bohm and Pines are verified by a quantum-mechanical calculation. The results are applied to the experiments of Ruthemann and Lang on the scattering of electrons by thin metallic films and to experiments on the stopping power of light metals for fast charged particles, with resulting good agreement between theory and experiment. (auth)

#### INSTRUMENTS

851

Atomic Energy Research Establishment, Harwell, Berks (England)

**DESIGN NOTES ON GROUNDED GRID POWER AMPLIFIERS**



WITH COAXIAL LINE CIRCUITS. J. Dain and I. A. D. Lewis. Aug. 26, 1953. 16p. (AERE-GP/M-159)

An analysis is developed of the tube current in a grounded-grid power amplifier. Relevant properties of coaxial-line cavities are quoted, and the design of the input and output circuits are examined. Criteria for the stability of the stage are given, and a numerical example is outlined by way of illustration. (auth)

852

Atomic Energy Research Establishment, Harwell, Berks (England)

A REVIEW OF EXPERIMENTS WITH A LINEAR MAGNETRON AMPLIFIER. J. Dain, J. L. Craston, L. S. Holmes, and J. M. Weaver. Aug. 1953. 44p. (AERE-GP/R-1227)

A brief outline of the theoretical and experimental design of a linear magnetron amplifier is followed by a description of several experiments carried out under pulse conditions on a wavelength of 10 cm. Low efficiency, power output, and gain were observed with no great hope of substantial improvement. (auth)

853

Brookhaven National Lab.

AN ALCOHOL DRIP APPARATUS FOR THE SLIDING MICROTOME. Peter J. Squicciarini. [1953?] 4p. (BNL-1643)

A drip apparatus is described which provides a constant and adjustable flow of alcohol for the lubrication of the microtome knife during wet sectioning of celloidin-embedded tissue. (C.H.)

854

North American Aviation, Inc.

THERMOMAGNETIC GENERATOR. G. W. Rodeback. Issued Nov. 15, 1953. 24p. Contract AT-11-1-GEN-8. (NAA-SR-264)

A feasibility study of the thermomagnetic generator, a device which converts heat energy into electromagnetic energy by thermal cycling in the temperature region just below the Curie point, is presented. The expected performance of various ferromagnetic materials has been calculated on the basis of a sinusoidal temperature cycle. The results indicate that the thermal efficiency to be expected from a thermomagnetic generator utilizing a ferromagnetic material is too low to warrant development of such a device. (auth)

## ISOTOPES

855

Research Foundation, Ohio State Univ.

A DEVICE FOR PLACEMENT OF COBALT-60 WITHIN RIGID OR FLEXIBLE TUBING FOR USE IN CANCER THERAPY. George W. Callendine, Jr. and Joseph L. Morton. [1953]. 12p. Contract [AT(11-1)-118] (AECU-2750)

A device for accurately positioning radioactive  $\text{Co}^{60}$  cylinders in rigid or flexible tubing is described. (auth)

## MASS SPECTROGRAPHY

856

TRACE ELEMENT DETERMINATION BY THE MASS SPECTROMETER. Mark G. Inghram. *J. Phys. Chem.* **57**, 809-14(1953) Nov.

The application of mass spectrometric technique to trace element determination in solids is reviewed. Three techniques which show promise are: (1) the Dempster vacuum spark method, (2) the ion bombardment method, and (3) the isotopic dilution method. Sensitivities of up to one part in ten to the tenth have been achieved. (auth)

## MATHEMATICS

857

Ballistic Research Labs., Aberdeen Proving Ground  
ASYMMETRIC ROTOR EIGENVALUE TABLE. T. E. Turner, B. L. Hicks, and G. Reitwiesner. Sept. 1953. 116p. (BRL-878)

A table of asymmetric rotor eigenvalues is given for  $J = 1(1)12$  and  $K = 0.00(0.01)1.00$ . A brief account of the asymmetric rotor theory is also given to serve both as a ready reference for the users of this table and as a basis for the explanation of the computation. The eigenvalues were computed on the EDVAC, and the methods of computation and checking are described. (auth)

858

Knolls Atomic Power Lab.

SOLUTION OF LARGE EQUATION SYSTEMS AND EIGENVALUE PROBLEMS BY LANCZOS' MATRIX ITERATION METHOD. G. Horvay. Oct. 14, 1953. 117p. (KAPL-1004)

The essentials of Lanczos' method for solving large equation systems and eigenvalue problems are described after a detailed introduction to matrix theory, the eigenvalue problem for Hermitian matrices, and general iteration methods. Lanczos' method of  $N$  iterations is first presented for symmetric matrices with simple eigenvalues and then extended to the asymmetric matrix, multiple eigenvalue case. The large number of iterations resulting from a matrix of high order is treated by application of the Lanczos-Chebyshev operator, reducing many iterations to relatively few steps. Further refinements of the basic method are outlined. (K.S.)

859

National Bureau of Standards

PROJECTS AND PUBLICATIONS OF THE NATIONAL APPLIED MATHEMATICS LABORATORIES. QUARTERLY REPORT [FOR] JULY THROUGH SEPTEMBER 1953. 83p. (NBS-2916)

Projects and publications of the Institute for Numerical Analysis, Computation Lab., Statistical Engineering Lab., and Machine Development Lab., including lists of lectures and symposia, are reviewed. (For preceding period see NBS-2688.) (K.S.)

860

EIGENVALUES AND EIGENVECTORS OF A PERTURBED OPERATOR. M. Z. Solomyak. *Doklady Akad. Nauk S.S.S.R.* **90**, 29-32(1953) May 1. (In Russian)

The results of M. K. Gavurin (*Doklady Akad. Nauk S.S.S.R.* **90**, No. 6 (1951)) in which eigenvalues and eigenvectors of a perturbed operator are evaluated in the case where an eigenvalue of the nonperturbed operator is simple (prime), are generalized for the case of multiple eigenvalues. (J.S.R.)

861

THEORY OF NONLINEAR AND LINEAR PROBLEMS OF EIGENVALUES. V. I. Kondrashov. *Doklady Akad. Nauk S.S.S.R.* **90**, 129-32(1953) May 11. (In Russian)

On the basis of investigations in  $W_p^m$  spaces, it is concluded that the completeness of a system of eigenfunctions is a consequence of the minimal properties of eigenvalues. The system of solutions of functional equations, which possesses properties of generalized completeness, coincided with a system of functions of the corresponding variational problems. (J.S.R.)

862

EXPANSION IN EIGENFUNCTIONS OF THE LAPLACE OPERATOR. B. M. Levitan. *Doklady Akad. Nauk S.S.S.R.* **90**, 133-5(1953) May 11. (In Russian)

The problem of finding the eigenvalues  $m_j^2$  of the system  $\Delta u + m^2 = 0$ ,  $u/B = 0$ , where  $B$  is the boundary of a certain finite domain  $D$  of a  $N$ -dimensional Euclidean space is considered. The corresponding functions  $w_j(P)$  ( $P$  is a point of

D) and the spectral function of the Laplace operator are discussed. (J.S.R.)

- 863  
A STATISTICAL GENERALIZATION OF THE QUANTUM MECHANICS (I). M. Schönberg. Nuovo cimento 10, 1499-1538(1953) Nov. 1. (In English)

It is shown that the ordinary Schrödinger equation for a dynamical system  $\Sigma$  may be replaced by a more general equation, which has the form of the Schrödinger equation of a quantized Bose field whose quanta are the systems  $\Sigma$ . The linear wave functionals of the quantized field describe pure states of the system  $\Sigma$ , and the non linear wave functionals describe, in general, mixtures of states of  $\Sigma$ . The representation in which the emission operators of the quantized  $\Sigma$  field are diagonal plays a central role in the present formalism. It is shown that the eigenfunctionals of the absorption operators of the quantized  $\Sigma$  field can be used to obtain a new description of the states of a system  $\Sigma$ , the expectation values of the field quantities in suitably chosen eigenstates of the emission operators coinciding with the expectation values of the corresponding quantities in the pure states of  $\Sigma$ , but the fluctuations being larger in the former case. The eigenfunctionals of the absorption operators have the remarkable property of being matrix elements of the unity operator of the field formalism, and seem to be of a more fundamental nature than the linear functionals which correspond to the ordinary description of the pure states by means of the wave functions of  $\Sigma$ . (auth)

- 864  
GENERALIZATION OF THE CLASSICAL FIELD FORMALISM BY MEANS OF FUNCTIONALS. M. Schönberg. Nuovo cimento 10, 1597-1601(1953) Nov. 1. (In English)

The method used to generalize the ordinary formalism of the quantum mechanics was used to generalize other classical field theories which admit a variational principle. The  $\chi$ -formalism of the quantized  $\phi$  field is analyzed by the introduction of constants. (J.S.R.)

- 865  
ON A NON-LOCAL FIELD THEORY. G. Wataghin. Nuovo cimento 10, 1602-4(1953) Nov. 1. (In English)

A new form of a nonlocal field theory is introduced. The form starts from the S-matrix formalism deduced by means of a perturbation theory based on the choice of a Hamiltonian and the use of the interaction representation. (J.S.R.)

- 866  
DIRAC'S ELECTRODYNAMICS AND EINSTEIN'S UNIFIED FIELD THEORY. G. Stephenson. Nuovo cimento 10, 1595-6(1953) Nov. 1. (In English)

By imposing different conditions in the Einstein unified theory, different electromagnetic theories may be obtained. In particular, it is found that the relation  $\Gamma_m \Gamma^m = \text{constant}$  allows the formulation of the generalization of the Dirac electrodynamics. In the weak field approximation, the theory is equivalent to the intuitive formulation of the Dirac theory in a Riemannian space. (J.S.R.)

#### MEASURING INSTRUMENTS AND TECHNIQUES

- 867  
Brookhaven National Lab.  
A HIGH SENSITIVITY FAST NEUTRON SURVEY METER. J. S. Handloser and W. A. Higinbotham. [1953?] 6p. (BNL-1613)

A compact portable instrument has been developed for the evaluation of fast neutron health hazards in the presence of intense  $\gamma$  radiation fields. Sufficient sensitivity is achieved to permit rapid measurement of fluxes in the range of the maximum permissible levels with a ratemeter circuit, and still lower levels may be detected by direct counting of individual pulses. Operation is unaffected by  $\gamma$

rays (from  $\text{Co}^{60}$ ) up to 4 r/hr. A molded cylinder of ZnS dispersed in lucite is used as the detector in conjunction with a 5819 photomultiplier. The ratemeter is driven by a one-shot multivibrator and has two ranges, covering fluxes (of Po-Be neutrons) of 10 to 200 and 60 to 2000 n/cm<sup>2</sup>/sec. (auth)

- 868  
Institute of Industrial Research, Syracuse Univ.  
NON-ELECTRONIC DOSE RATE INDICATING SYSTEMS. FIFTH QUARTERLY PROGRESS REPORT [FOR] JUNE 15, 1953 [TO] SEPTEMBER 15, 1953. Herbert Rubin. 20p. Contract DA-36-039-SC-15533. (NP-4928; Quarterly Progress Report No. 5)

Densitometer tracings of phosphorescence and glow curve spectra of some glasses were obtained. These spectra are similar, and indicate that the excited state formed by recombination is the triplet state of the molecule. The results of continued work on the properties of the ferrous thiocyanate-pyridine system are reported. Its response to x rays and ultraviolet light is discussed. Also, the reversibility of the oxidation-reduction cycle in the presence of Hg was demonstrated. With the view of studying the oxidation-reduction processes of inorganic halides in organic halide solvents under radiolysis, a search for suitable solvents was begun. A kinetic study of the radiolysis of inorganic iodides in  $\text{CCl}_4$  is now in its early stages. (For preceding period see NP-4641.) (auth)

- 869  
Evans Signal Lab., Signal Corps Engineering Labs.  
IONIZATION CHAMBER INSTRUMENTS AND TECHNIQUES. A SUMMARY OF THE TECHNICAL MINUTES OF THE SIGNAL CORPS ENGINEERING LABORATORIES RADIAC SYMPOSIUM, SEPTEMBER 14-16, 1949. Charles K. Shultes, ed. 146p. (NP-4963)

- 870  
Geological Survey  
THEORETICAL ALPHA STAR POPULATIONS IN LOADED NUCLEAR EMULSIONS. F. E. Senftle, T. A. Farley, and L. R. Stieff. Nov. 1953. 25p. (TEI-374)

Calculations have been made of  $\alpha$  star populations in loaded nuclear emulsions. Equations are presented for calculation of star types for each significant emitter in the three naturally radioactive series. The application of five-branched star populations as a method of quantitative analysis for microgram amounts of Th is proposed. (auth)

- 871  
Atomic Energy Project, Univ. of Calif., Los Angeles  
THE APPLICATION OF SUBMINIATURE TECHNIQUES TO NUCLEAR INSTRUMENTS—A PORTABLE SCALER FOR OPERATION FROM 6 VOLTS DC OR 115 VOLTS AC. Jacob E. Dietrich, John B. Hall, and William R. Kennedy. Issued Nov. 30, 1953. 19p. Contract AT-04-1-GEN-12. (UCLA-273)

A scaler which makes use of subminiature techniques is described. The scaler has a photomultiplier tube built in for  $\alpha$  scintillation measurements as well as an external connector for G-M tube counting. The unit has been designed for operation from an a-c line or a 6-v storage battery. Most of the tubes used are subminiature, and much of the circuit has been arranged in layout and conduction paths as in typical printed circuitry. Some preliminary work with other components for flip-flops, particularly transistors, is described. The use of transistors in nuclear instrumentation is particularly appealing considering the size, power consumption, and possibly the operating life. (auth)

- 872  
Radiation Lab., Univ. of Calif., Berkeley  
THE LIQUID SCINTILLATION COUNTING OF TRITIUM



AND C<sup>14</sup>-LABELED COMPOUNDS. Donald J. Rosenthal and Hal O. Anger. Aug. 21, 1953. 21p. Contract W-7405-eng-48. (UCRL-2320)

Utilizing the liquid-scintillation principle of counting, a relatively simple counter for very weak  $\beta$  particles has been developed. The counter is stable, accurate, and more sensitive than the ionization chamber-vibrating reed electrometer method of measuring tritium, and, for the same time interval, allows one to count many more samples than with the chamber method. The main features of the instrument are the use of an efficient liquid-scintillator solution, and a photomultiplier tube that has a very high signal-to-noise ratio, and which is also cooled to further reduce the noise background. The method is suitable for counting H<sup>3</sup>- or C<sup>14</sup>-labeled compounds that are soluble in the ordinary fat solvents, and which do not color or quench the scintillator solution. If they are first mixed with absolute ethanol, tritium-labeled water or aqueous solutions of tritium-labeled compounds can also be counted with good efficiency. Samples are prepared for counting by merely dissolving them in or mixing them with the liquid-scintillator solution. The apparatus required is relatively inexpensive and uncomplicated, and is available commercially. (See also UCRL-2345.) (auth)

873 LIQUID SCINTILLATION COUNTING OF NATURAL C<sup>14</sup>. F. N. Hayes, D. L. Williams, and Betty Rogers. Phys. Rev. **92**, 512-13(1953). Oct. 15.

It was found that the counting rate of the liquid scintillation solvent *p*-cymene containing natural C<sup>14</sup> varied greatly according to the primary origin of the solvent. Consistently high rates were obtained in material derived from atmospheric CO<sub>2</sub>, and low results were obtained in samples synthesized from petroleum chemicals. By means of a Los Alamos Model 530 coincidence-anticoincidence system the specific activity of C<sup>14</sup> in contemporary *p*-cymene was found to be  $12.9 \pm 0.2$  dpm/g. (K.S.)

874 A SCINTILLATION DETECTOR FOR NEUTRONS OF INTERMEDIATE ENERGY. E. R. Rae and E. M. Bowey. Proc. Phys. Soc. (London) **A66**, 1073-4(1953) Nov.

A neutron detection apparatus is described in which the  $\gamma$  rays from the B<sup>10</sup>( $n, \alpha \gamma$ )/Li<sup>7</sup> reaction are detected in a NaI scintillation spectrometer. The device has been used for some time with the time-of-flight equipment of the Harwell linear accelerator. (auth)

875 IONIZATION LOSS AT RELATIVISTIC VELOCITIES IN NUCLEAR EMULSION. Bertram Stiller and Maurice M. Shapiro. Phys. Rev. **92**, 735-41(1953) Nov. 1.

The variation of grain density in the tracks of singly charged relativistic particles traversing a nuclear emulsion has been investigated as a function of velocity in Ilford G5 plates exposed to cosmic radiation at 100,000 ft. Multiple-scattering measurements and "blob counts" were made on long tracks of electrons, mesons, and protons with energies  $\gamma$  up to 3400 rest mass units. The blob density  $G_{pl}$  at the Fermi plateau of ionization was found to be  $1.14 \pm 0.03$  times  $G_{min}$ , in agreement with the result previously obtained by another method. Protons and electrons show the same value of  $G_{pl}$ . The data are compared with the theories of Halpern-Hall and of Sternheimer for AgBr, by use of the ionization potentials of Bakker and Segrè. Since only grains along the track were counted, the calculated energy loss is restricted to energy transfers less than an upper limit  $T_0$ . Calculations for two assumed values of  $T_0$ , 2 kev and 5 kev, fit the data equally well, yielding ratios  $G_{pl}/G_{min}$  of 1.15 and 1.14, respectively. The data are also consistent with the slow rate of rise from minimum

( $\gamma \sim 4$ ) to plateau ( $\gamma > 100$ ), which is predicted by the theory. (auth)

876 THE PRODUCTION OF DELTA-RAYS IN NUCLEAR-RESEARCH EMULSIONS. D. A. Tidman, E. P. George, and A. J. Herz. Proc. Phys. Soc. (London) **A66**, 1019-31(1953) Nov. 1.

Theoretical formulas are derived which give the  $\delta$ -ray density as a function of the velocity and charge of the primary particle, taking into consideration the fact that the electrons in the emulsion are both bound and in motion. The two main types of convention used in deciding which configurations of grains are to be accepted as  $\delta$  rays are investigated; those in which the  $\delta$  rays must contain more than a specified number of grains, and those in which they must reach a specified distance from the primary track. Account is taken, where necessary, of straggling, multiple scattering, and the fluctuations in the numbers of grains in electron tracks. The theory is compared with the results of  $\delta$ -ray counts on the tracks of singly charged particles of known velocity. The agreement is very good in the case of the conventions based on range, and fairly satisfactory for the grain-number conventions. The range conventions are found to be preferable in practice as they are more easily learned and more objective than those in which numbers of grains have to be estimated. (auth)

877 THE VARIABLE-RADIUS SEMICIRCULAR MAGNETIC FOCUSING  $\beta$ -RAY SPECTROMETER. C. G. Campbell and J. Kyles. Proc. Phys. Soc. (London) **B66**, 911-20(1953) Nov. 1.

Li's method for determining the line shape in a variable-radius spectrometer is discussed, and a rapid approximate method is given. Methods of normalization for the continuous  $\beta$ -particle spectrum and for conversion electron lines are presented. The advantages and disadvantages of this type of spectrometer are discussed. (auth)

878 INVESTIGATIONS ON A SHORT MAGNETIC LENS SPECTROMETER. M. K. Banerjee and A. K. Saha. Proc. Phys. Soc. (London) **B66**, 937-48(1953) Nov. 1.

In the course of an attempt to find reversible relations between the parameters describing the trajectory of an electron in a short magnetic lens spectrometer, it was found that the magnetic lens can be surprisingly well represented by a thick converging-type optical lens which satisfies Newton's laws for the conjugate planes and the tangent relation far outside the paraxial range where the lens power calculated by the paraxial method can be in error by as much as 50%. Expressions have been obtained for the focal length as a function of the object angle and momentum of the electron. Various other properties of the lens spectrometer have been investigated. In particular, the use of a continuous baffle system to improve the resolution and line shape for an extended source has been studied by an easy and accurate method. (auth)

879 THE DIFFRACTION OF 150 kv ELECTRONS. G. I. Finch, H. C. Lewis, and D. P. D. Webb. Proc. Phys. Soc. (London) **B66**, 949-53(1953) Nov. 1.

An electron diffraction camera operating at voltages up to 150 kv is described. The advantages of the use of high accelerating potentials are illustrated by results obtained with this camera. (auth)

880 IONIZATION LOSS IN NUCLEAR EMULSIONS. John R. Fleming and J. J. Lord. Phys. Rev. **92**, 511-2(1953) Oct. 15.

A study of grain density vs. velocity of singly charged

particles in an Ilford G-5 emulsion is reported. Specific data are given for electrons of 34-Mev energy and negative pions of 224-, 121-, 80-, and 24-Mev energy. Results on the relativistic rise of track density are shown to be in good agreement with previous work. (K.S.)

881

HIGH-ENERGY BUNCHED BEAM ANALYZER. Irving Kaufman. *J. Appl. Phys.* **24**, 1413(1953) Nov.

A scheme is presented for measuring the bunch length of high-energy electron beams by converting the space variation of the beam into an energy variation. After passing through a microwave cavity, the emergent beam has an output kinetic energy curve of nearly sinusoidal shape. When the output bunch is then passed through a magnetic field, the electrons are separated according to their energy modulation. Dispersion may be enhanced by correctly shaping the magnet pole pieces. In a typical case, a bunch length of 0.3 mm produces a display of width 3.9 cm. (L.M.T.)

882

EFFECT OF LOW TEMPERATURES ON NUCLEAR EMULSIONS. M. Debeauvais-Wack. *Nuovo cimento* **10**, 1590-4(1953) Nov. 1. (In French)

The behavior of nuclear emulsions at low temperatures ( $-85$  and  $-180^\circ$ ) was studied. It is possible to develop and observe the plates which have been kept for several weeks at these low temperatures if the emulsion rests on a support of celluloid. With a maximum development, the  $C_2$  plates show no traces of  $\alpha$  tracks at  $-180^\circ$  as any  $\alpha$  tracks disappear at  $-85^\circ$ . In the  $G_2$  the tracks of  $\alpha$  particles are re-ordered and are found in separate grains at  $-180^\circ$  and continue in that form to  $-85^\circ$ . Electrons of approximately 0.5 Mev are recorded at  $-85^\circ$ . The technique of exposure at low temperatures can be used to distinguish traces, to diminish the diffusion of gases such as  $Rn$ , and to retard the chemical action of the samples in contact with nuclear plates. (tr-auth)

## MESONS

883

A SUMMARY OF K-MESON DATA. L. Leprince-Ringuet and B. Rossi. *Phys. Rev.* **92**, 722-3(1953) Nov. 1.

The results of experiments on K mesons performed at the École Polytechnique of Paris and at the Mass. Inst. of Tech. are summarized and analyzed. (auth)

884

SEARCH FOR V PARTICLES PRODUCED BY 430-MEV PROTONS. A. H. Rosenfeld and S. B. Treiman. *Phys. Rev.* **92**, 727-9(1953) Nov. 1.

Polyethylene was bombarded with 430-Mev protons from the Chicago synchrocyclotron, and a search carried out in nearby nuclear emulsions for  $V_1^0$  particles, as well as for possible charged analogs which decay by the process  $V_1^+ \rightarrow \pi + \pi^+ + Q$ . No events of either type were found. The upper limits of the cross sections are respectively 0.35 and 0.15 mb per C nucleus for the  $V_1^0$  and  $V_1^+$ . (auth)

885

PRODUCTION OF NEUTRAL MESONS BY 340-MEV PROTONS ON HYDROGEN. J. W. Mather and E. A. Martinelli. *Phys. Rev.* **92**, 780-9(1953) Nov. 1.

The production of neutral mesons by 340-Mev protons on H has been measured directly by detecting a single  $\gamma$  ray from the two  $\gamma$ -ray decay of a neutral meson, at  $90^\circ$  to the proton beam. A liquid H target and a focusing Cherenkov counter are described. The ratio of the cross section for neutral meson production from H relative to C is  $\sigma_H/\sigma_C = 0.0059 \pm 0.0009$ , where the error is standard deviation. By use of the absolute cross section of neutral meson production from C as  $1.5 \times 10^{-27}$  cm<sup>2</sup>, the neutral meson production

cross section for H is found to be  $8.8 \times 10^{-30}$  cm<sup>2</sup>. The transition  $P^3 \rightarrow S^1$  (allowed by the conservation of angular momentum and parity) for the protons can be interpreted as a triplet p-state interaction with emission of an s-state neutral meson. The agreement with the existing data at proton energies of 440 Mev is fair. The 340- and 440-Mev data give two points on the neutral meson excitation function curve, showing a steep rise. The experimental results give some evidence for the breakdown of the approximate selection rule which forbids the emission of s-state neutral mesons with final s-state nucleons. The relative cross section for C and N indicates that the yield of neutral mesons is due to the interaction of the incident protons with the neutrons in the nuclei. (auth)

886

ON THE SCATTERING OF  $\mu$ -MESONS BY NUCLEI. R. Gatto. *Nuovo cimento* **10**, 1559-81(1953) Nov. 1. (In English)

Recent experiments have lead to unexpectedly large cross sections for anomalous scattering of  $\mu$  mesons. It is here examined whether a better evaluation of the electromagnetic contributions can diminish this discrepancy. The incoherent electric cross section and the dependence on the nuclear model employed are here considered in detail. To calculate the incoherent contribution the closure approximation is used. A discussion is given of its validity, and in some cases the results are compared with those of calculations which do not use the closure approximation. It is concluded that the incoherent contribution cannot explain the large anomalous cross sections. (auth)

887

AN INVESTIGATION ON JETS. C. Castagnoli, G. Cortini, C. Franzinetti, A. Manfredini, and D. Moreno. *Nuovo cimento* **10**, 1539-58(1953) Nov. 1. (In English)

The authors present a statistical method for the determination of the energy of the primary of a nucleon-nucleon collision in which secondary particles are produced. Such a method, which represents an appreciable improvement with respect to the procedures used by other authors, makes use of all the information that can be obtained from the measurements of the angles of the shower particles of a jet. The statistical error on the energy of the primary is given by a very simple formula and turns out to be always very large and increases with the anisotropy of the emitted particles in the center of gravity frame of reference. The method, which can be applied by successive approximations, is used to discuss 43 jets due to p (28), n (6), and  $\alpha$  (9) primaries. Besides the energy per nucleon of the primary of each jet, some information on the angular distribution of the emitted particles in the center of gravity system is deduced. The first approximation is based on the assumption that all the emitted particles have, in the center of gravity frame of reference, the same velocity as the two colliding nucleons before the collision. A critical discussion of the determination of the energy of the primary shows that the result of this approximation has not, in general, much significance. The solution of second approximation needs the knowledge of the spectrum of the emitted particles and depends rather strongly on such a spectrum; if the experimental spectrum is reasonably well represented by a formula of the same type as that of Fermi's thermodynamical theory, the determination of the energy will be fairly satisfactory only if it is at least 50 bev. But if the experimental spectrum can be represented for energies of the emitted particles much larger than  $m_\pi c^2$ , by a formula of the same type as that of Heisenberg, the evaluation of the energy of the primary will depend very strongly on the behavior of the adopted spectrum at low energy for ultrarelativistic collisions. (auth)



888

ELASTIC PHOTOPRODUCTION OF  $\pi^0$ 's FROM DEUTERIUM. J. W. DeWire, A. Silverman, and B. Wolfe. *Phys. Rev.* **92**, 520-1(1953) Oct. 15.

The  $\gamma + D \rightarrow \pi^0 + D$  reaction was investigated with  $\gamma$  rays of 250 to 300 Mev, and  $\pi^0$  mesons between 90 and 120° in the laboratory system were measured. The results of the experiment are interpreted with the view of determining the relative sign of the neutron and proton  $\pi^0$  coupling constants. It is concluded from these preliminary studies that  $g_p = -g_n$ . (K.S.)

## NEUTRONS

889

Atomic Energy Research Establishment, Harwell, Berks (England)

THE CALCULATION OF THE SPECTRUM OF NEUTRONS AT POINTS IN A SEMI INFINITE HYDROGENOUS MEDIUM, WHOSE FREE SURFACE IS IRRADIATED BY MONOENERGETIC NEUTRONS FALLING NORMALLY ONTO IT. J. H. Tait and M. B. Biram. Oct. 28, 1953. 13p. (AERE-T/M-92)

A calculation is made of the neutron spectrum at points in a semi-infinite hydrogenous medium. Capture is neglected, and cross sections are assumed to vary as  $1/v$ . A spherical harmonics  $P_1$  approximation is used, and a particular solution is obtained which, when modified to give the correct value and derivative at the initial velocity, is shown to give an accurate description of the spectrum. (auth)

890

Atomic Energy Research Establishment, Harwell, Berks (England)

DEGRADATION OF FAST NEUTRON SPECTRUM BY A LIGHT REFLECTOR. J. P. Elliott. Aug. 1953. 18p. (AERE-T/R-1244)

By use of a simple spherical model consisting of a core, a reflector of light material, and a U blanket, a method is given to determine the velocity distribution of neutrons in the core. It is assumed that all cross sections are independent of energy, that slowing down takes place only in the reflector and that fission takes place only in the core. Calculations are made for Be reflectors of thickness 3 cm and 6 cm and for Al reflectors of thickness 3 cm and 30 cm. The energy released in the reflector by slowing down of neutrons is also calculated. (auth)

## NUCLEAR PHYSICS

891

LIMITS OF APPLICABILITY OF THE THEORY OF BREMSSTRAHLUNG ELECTRONS AND PAIR PRODUCTION FOR HIGH ENERGIES. L. Landau and I. Pomeranchuk. Translated from *Doklady Akad. Nauk S.S.S.R.* **92**, 535-6(1953). 2p. (NSF-tr-136)

It is shown that the Bethe-Heitler equations are inapplicable to the theoretical analysis of bremsstrahlung and pair production at high energies in an extended medium. (K.S.)

892

THE GENERAL THREE-DIMENSIONAL THEORY OF CASCADE PROCESSES. H. Messel and H. S. Green. *Proc. Phys. Soc. (London)* **A66**, 1009-18(1953) Nov. 1.

A mathematical treatment is given of the general three-dimensional theory of a cascade shower developing in a medium in which the number density of the constituent atoms may vary from point to point. This treatment reduces the work of obtaining all angular and radial moments to a drill. The case of the soft component developing in an extensive air shower initiated by a primary nucleon is worked out as an illustration. (auth)

893

STUDIES IN INTERMEDIATE COUPLING: THE ENERGY STATES OF  $^{13}\text{C}$  AND  $^{13}\text{N}$  BELONGING TO THE CONFIGURATION  $1p^2$ . A. M. Lane. *Proc. Phys. Soc. (London)* **A66**, 977-94(1953) Nov.

The nuclear shell model and the theory of fractional parentage are used to derive theoretical formulas for certain observable features of nuclear energy levels that are not expected to be sensitive to the choice of the nucleon interaction potential. These features comprise the magnetic dipole transition strengths, the magnetic moments, and the reduced widths for nucleon emission. Intermediate coupling, besides extreme L-S and extreme j-j coupling, is discussed, and the resulting formulas are applied to the low-lying odd-parity states of  $\text{C}^{13}$  and  $\text{N}^{13}$  in an attempt to explain all the relevant experimental data. It is found that the extreme-coupling models give generally poor agreement of theory with experiment. On the other hand, all the data are consistent with an intermediate-coupling model and quite a small range of values of the intermediate-coupling parameter. (auth)

894

JASTROW'S NUCLEAR MODEL FOR HIGH ENERGY ELECTRON SCATTERING. A. L. Mathur and K. M. Gatha. *Proc. Phys. Soc. (London)* **A66**, 1075-6(1953). Nov.

The authors in a previous note (*Proc. Phys. Soc. (London)* **A66**, 773(1953)) obtained the missing parameter for the Born-Yang nuclear model on the basis of the nuclear scattering of high-energy electrons. In a later model which Jastrow proposed for the nuclear scattering of nucleons, the parameter  $r_0$  was left undetermined. By means of the same procedure, the nuclear scattering of high-energy electrons,  $r_0$  is determined for the Jastrow model, and the scattering amplitudes of the two models are compared. (L.M.T.)

895

NEW METHOD FOR DETERMINING THE MASS OF CHARGED PARTICLES BY MEANS OF PHOTOEMULSION. V. V. Chavchanidze. *Zhur. Eksptl'. i Teoret. Fiz.* **23**, 502-11(1952) Nov. (In Russian)

The phenomenon of multiple scattering is used to study lateral deviations of track grains in photoemulsions relative to the direction of specially drawn tangents to the particle track. In plotting the calibration curve of mass and energy, account is taken of the effect of ionization losses in the distribution function of deviations on the depth of penetration in the emulsion. (J.S.R.)

## NUCLEAR PROPERTIES

896

Brookhaven National Lab.

THE NUCLEAR MOMENTS OF  $\text{Se}^{79}$ . W. A. Hardy, G. Silvey, and C. H. Townes, Columbia Univ.; B. F. Burke and M. W. P. Strandberg, Research Lab. of Electronics, Mass. Inst. of Tech.; George W. Parker, Oak Ridge National Lab.; and Victor W. Cohen, Brookhaven National Lab. [1953] 22p. (BNL-1605)

Microwave measurements of the  $J = 2 + 3$  rotational transition of  $\text{OCSe}$  containing the radioactive nucleus  $\text{Se}^{79}$  have established the  $\text{Se}^{79}$  spin as  $\frac{7}{2}$  and the  $\text{Se}^{79}$  quadrupole moment as  $0.7 \times 10^{-24} \text{ cm}^2 \pm 20\%$ . The quadrupole coupling constant is  $752.09 \pm 0.05 \text{ Mc/sec}$ . The magnetic moment of  $\text{Se}^{79}$  has been determined as  $-1.015 \pm 0.015 \text{ n.m.}$  by observation of the Zeeman splitting of one hyperfine component. The  $\frac{7}{2}$  spin and the large positive  $Q$  are inconsistent with the single-particle nuclear shell model but suggest the configuration  $(g_{\frac{7}{2}})_{\frac{7}{2}}$ . This assignment is substantiated by the negative magnetic moment. Measurement of isotopic shifts gives a value for the  $\text{Se}^{79}$  mass and an odd-even mass difference of 2.4 millimass units for this nucleus. (auth)

897

Brookhaven National Lab.

THE NUCLEAR QUADRUPOLE COUPLING IN POLAR MOLECULES. R. M. Sternheimer, Brookhaven National Lab., and H. M. Foley and D. Tycko, Columbia Univ. [1953]. 28p. (BNL-1628)

The effect of an external charge on the nuclear electric quadrupole coupling has been investigated for various ions. These results presumably apply to the case of polar molecules. The quadrupole moment induced by the nuclear quadrupole moment  $Q$  is 46.5 $Q$ , 8.7 $Q$ , 50.2 $Q$ , and 86.8 $Q$  for the  $Cl^-$ ,  $Cu^+$ ,  $Rb^+$ , and  $Cs^+$  ions, respectively. When an external charge interacts with the ion as in a polar molecule, the induced moment is added to  $Q$ , so that the quadrupole coupling is multiplied by a factor of order 10 to 100. This model of a polar molecule disregards the exchange repulsion between the ions. Evidence is presented from several molecules which seems to confirm the existence of the induced quadrupole moment, although there is only partial agreement with the experimental values. It is shown that the contribution to the quadrupole coupling resulting from the induced dipole moment in second order is small compared to the induced quadrupole effect. (auth)

898

Naval Research Lab.

GAMMA RADIATION FROM INTERACTION OF 3.3 MEV NEUTRONS WITH LEAD. V. E. Scherrer, B. A. Allison, and W. R. Faust. Oct. 23, 1953. 5p. (NRL-4252)

Observations have been made of  $\gamma$  rays produced by bombardment of Pb with 3.3-Mev neutrons. Various  $\gamma$ -ray lines have been identified, and calculations of  $\gamma$ -ray production cross sections have been made. (auth)

899

Nuclear Development Associates, Inc.

TABLE OF NEUTRON RESONANCE CONSTANTS. Bernard T. Feld, comp. Aug. 28, 1953. 31p. Contract AT (30-1)-862B. (NYO-3078; NDA-15B-6)

Constants associated with the neutron resonance phenomena of all nuclei are tabulated from data compiled during the summer of 1952. The data include values for the neutron resonance energy  $E_r$ , compound nucleus spin  $J$ , resonance level width  $\Gamma_n$ ,  $\gamma$ -ray width  $\Gamma_\gamma$ , appropriate neutron cross sections, average level spacing  $\bar{D}$ , and intrinsic level spacing  $D^*$ . (K.S.)

900

CONTRIBUTION TO THE THEORY OF THE PHYSICAL QUANTITIES ASSOCIATED WITH PARTICLES WITH SPIN  $\frac{1}{2}$ . Judith Winogradzki. *Ann. phys.* **8**, 763-812 (1953) Sept-Oct. (In French)

An interpretation of the Dirac equation and a study of its consequences have introduced some physical quantities in which the operators act upon the variable of spin. This work is a study of the physical quantities associated with particles with spin  $\frac{1}{2}$ , in which the operators act only on the spin variable and are invariant with respect to the Lorentz transformations. The general principles of wave mechanics, the fundamental postulate, and the transformation laws of the wave function which characterize the particle determine the form of the densities for the average value of the physical quantities and the structure of the operators associated with those observed. These form eight families with two parameters. The equality of the range of the physical quantities is one of their essential characteristics. The general spinor form of the average value of the densities depends on the equality of the range of the physical quantities. The operators, associated with those observed of the same equality, have in common some important properties, a characteristic of the equality. In the limits of this work, the new physical quantities of

equal range are distinguished very little from the classical physical quantities. But their components (at least when it was only a question of the components of certain physical quantities closely connected with the classic quantities) could not be measured at the same time as an observable classic pair. On the contrary, the new physical quantities of unequal range are distinguished sharply, in general, from the classic physical quantities. It is noted that a new observed inequality determines the aggregate of the observable of the same variance. (tr-auth)

901

THE QUADRUPOLE TRANSITION IN THE NUCLEAR PHOTOEFFECT IN THE DEUTERON. Herbert Überall and Fritz Schlesinger. *Acta Phys. Austriaca* **7**, 355-64 (1953) Sept. (In German)

The formula for the effective cross section of the electric quadrupole transition was derived by application of the potential well model for the deuteron, and the energy dependence was discussed. It is shown that, at low energies, the quadrupole effective cross section produces only a small correction of the dipole effective cross section. It attains, at about 55 Mev, the same order of magnitude as the dipole effective cross section and decreases at higher energies, as 60 Mev, in the same manner as the dipole effective cross section. (tr-auth)

902

MEASUREMENT OF THE VELOCITY OF PROTONS ACCORDING TO THE CHERENKOV EFFECT. L. N. Bell. *Priroda* **41**, 104-6 (1952) Nov. (In Russian)

In order to observe Cherenkov's effect, protons have to be accelerated to at least 170 Mev. Such energy was attained recently, and the effect could be observed experimentally. Cherenkov's effect permitted estimation of proton energy to an accuracy of  $\pm 0.2$  Mev for a total energy of 340 Mev. (J.S.R.)

903

ALPHA-ALPHA SCATTERING FROM 12.88 TO 21.62 MEV. F. E. Steigert and M. B. Sampson. *Phys. Rev.* **92**, 660-4 (1953) Nov. 1.

The differential scattering cross section of  $\alpha$  particles on He has been investigated as a function of energy in the range from 12.88 to 21.62 Mev. The data obtained indicate a very strong angular dependence. This further appears to be a fairly sensitive function of energy. At the lower excitations there is a rather singular interference between the Coulomb and nuclear interactions. Above 20 Mev, interferences among the various components of the nuclear phase shifts again give rise to marked singularities. These data have been analyzed with respect to the phase shifts arising from the angular momentum components of the interaction. This decomposition indicated resonances at 7.55 and 10.8 Mev with widths,  $\Gamma$ , of 1.2 Mev in each case and state assignments of 0 and 4, respectively. (auth)

904

STUDIES OF X-RAYS FROM MU-MESONIC ATOMS. Val. L. Fitch and James Rainwater. *Phys. Rev.* **92**, 789-800 (1953) Nov. 1.

A new technique of x-ray spectroscopy of  $\mu$ -mesonic atoms has been developed. The x rays are produced when a  $\mu^-$  meson undergoes transitions between Bohr orbits about nuclei of various  $Z$ . The mesons are produced by the Columbia Univ. 164-in. Nevis cyclotron. The x rays are detected, and their energies are measured to better than 1% accuracy (for  $Z \geq 22$ ) by use of a NaI crystal scintillation spectrometer. The  $2p \rightarrow 1s$  transition energies were measured to be 0.35, 0.41, 0.955, 1.55, 1.60, 3.50, 5.80, 6.02, and 6.02 Mev for  $Z = 13, 14, 22, 29, 30, 51, 80, 82$ , and 83. Special attention was paid to the Pb spectrum, and it is believed that an 0.2-Mev fine-structure splitting has been



observed. This is the expected splitting if the  $\mu^-$  meson is a spin  $\frac{1}{2}$  Dirac "heavy electron" of 210 electron masses, having the expected Dirac magnetic moment and having no strong nonelectromagnetic interaction with nuclear matter. Since the  $\mu^-$  meson Bohr orbits are 210 times closer to the nucleus than the equivalent electron orbits, the x-ray energies are quite sensitive to nuclear size for medium and large  $Z$ . In the case of Pb, a 1% change in nuclear radius gives a 1% change in the calculated x-ray energy. By assuming constant proton density inside a spherical nucleus of radius  $R_0 = r_0 A^{1/3}$  and the above properties for the  $\mu$  meson,  $r_0 = 1.17, 1.21, 1.22$ , and  $1.17 \times 10^{-13}$  cm for  $Z = 22, 29, 51$ , and  $82$ . The significance of these results in relation to other nuclear size measurements is discussed. (auth)

905

SLOW NEUTRON VELOCITY SPECTROMETER STUDIES. V. Re, Ta, Ru, Cr, Ga. E. Melkonian, W. W. Havens, Jr., and L. J. Rainwater. *Phys. Rev.* **92**, 702-15(1953) Nov. 1.

New developments in the analysis of data near resonance levels are described. These allow more accurate values of the level constants to be determined from the measured areas above transmission curves and are more general in their applications. The effect of Doppler broadening is also taken into consideration. Transmission data on Re, Ta, Ru, Cr, and Ga are presented. The thermal region of Re is well matched by the relation  $\sigma = 5.0 + 15.8E^{-1/2}$ . Resonances are found in Re at 2.18, 4.40, 5.92, 7.18, 11.3, 13.1, 17.7, and 21.1 ev. The strong level at 2.18 ev has been studied by the technique of using two samples of different thickness, giving  $\sigma_0 = 5700$  barns and  $\Gamma = 0.090$  ev. The method of curve fitting was also applied to the transmission dip of the thick sample at 2.18 ev and confirms the values of  $\sigma_0$  and  $\Gamma$  from the area method. Curve fitting was also used on the 4.40-ev level. New data for Ta in the region above 5 ev are presented. Some transmission dips thought previously to be due to one level have now been resolved into two levels. There are levels at 6.11, 10.2, 13.7, 20.0, 24.0, 35.1, and 38.2 ev. The thermal region of Ru is well matched by the relation  $\sigma = 6.4 + 0.39E^{-1/2}$ . Resonance levels are observed at 9.8, 15.2, 24.1, and 40.9 ev. The thermal region of Cr is well matched by the relation  $\sigma = 3.8 + 0.7E^{-1/2}$ . A resonance level is observed at 3800 ev. The nuclear cross section of Ga is given by  $\sigma = 7.3 + 0.35E^{-1/2}$  below 5 ev. In addition, interference effects occur in the thermal region. Levels were found at 102 ev and 310 ev, with indications of levels at higher energies. (auth)

906

MU-MESONIC ATOMS AND THE ELECTROMAGNETIC RADIUS OF THE NUCLEUS. L. N. Cooper and E. M. Henley. *Phys. Rev.* **92**, 801-11(1953) Nov. 1.

An attempt is made to interpret recent experiments on the x-ray spectrum of  $\mu^-$  mesonic atoms. In particular, an analysis is made of the  $2p - 1s$  transition energies, which are sensitive to the nuclear charge distribution. Agreement with experiment is obtained for a uniform sphere of nuclear charge of radius  $R \approx 1.2 \times 10^{-13} A^{1/3}$  cm. Various effects such as nuclear polarization, electric quadrupole moment, screening by atomic electrons, and a meson-nucleon interaction of the order indicated by the charge-exchange capture reaction are considered and do not alter this radius appreciably. However, an anomalous meson-nucleus interaction, though doubtful, could alter the estimated radius. It is shown that the small nuclear radius is not in disagreement with that determined by other electromagnetic measurements, including mirror nuclei experiments. (auth)

907

MU MESON AS NUCLEAR PROBE PARTICLE. John A. Wheeler. *Phys. Rev.* **92**, 812-6(1953) Nov. 1.

The  $\gamma$  ray ("Chang radiation") given out in the transition of a meson to the  $1s$  ground state from a  $2p$  orbit around a heavy nucleus of nonzero quadrupole moment is concluded to consist of several components of appreciable separation. Measurements of their energies should give information on (1) nuclear radius, (2) nuclear quadrupole moments, (3) the magnetic moment of the meson, (4) the nonuniformity of the nuclear charge distribution, and (5) nuclear polarizability and compressibility. (auth)

908

ON THE EXISTENCE OF A BOUND STATE OF  $^4\text{He}$ . P. Swan. *Proc. Phys. Soc. (London)* **A66**, 1066-7(1953). Nov.

Examination is made of  $\text{H}^4$  by means of the appropriate resonating group-structure wave function, from which it is found that no bound state exists for any of four alternative types of nuclear force. (L.M.T.)

909

THE 7.68-MEV STATE IN  $\text{C}^{12}$ . D. N. F. Dunbar, R. E. Pixley, W. A. Wenzel, and W. Whaling. *Phys. Rev.* **92**, 649-50(1953) Nov. 1.

Magnetic analysis of the  $\alpha$ -particle spectrum from  $\text{N}^{14}(\text{d}, \alpha)\text{C}^{12}$  covering the excitation-energy range from 4.4 to 9.2 Mev in  $\text{C}^{12}$  shows a level at  $7.68 \pm 0.03$  Mev. At  $E_d = 620$  kev,  $\theta_{\text{lab}} = 90^\circ$ , transitions to this state are only 6% of those to the level at 4.43 Mev. (auth)

910

TOTAL NEUTRON CROSS SECTION OF PHOSPHORUS. K. F. Hansen, R. M. Kiehn, and Clark Goodman. *Phys. Rev.* **92**, 652-3(1953) Nov. 1.

The total cross section of P for neutrons has been measured in good geometry by the transmission method with a resolution of 2 kev. The energy range is from 125 to 850 kev, the neutrons being produced by the  $\text{Li}^7(p, n)\text{Be}^7$  reaction. Red P contained in a thin steel cylinder was used as scatterer. The neutrons were detected by a H recoil counter. The neutron beam was monitored by a  $\text{BF}_3$  long counter. The average cross section is 3 barns with an average level spacing of about 25 kev. (auth)

# NUCLEAR REACTORS

911

Oak Ridge National Lab. SPECTRUM OF GAMMA RAYS EMITTED BY THE BULK SHIELDING REACTOR. F. C. Maienschein and T. A. Love. Oct. 31, 1953. 6p. Contract W-7405-eng-26. (CF-53-10-16)

Gamma spectra from the Bulk Shielding Reactor were measured after loading the reactor with "cold" fuel elements. One end of an air-filled Al tube was placed against the face of the reactor and extended to a three-crystal spectrometer which was shielded from  $\gamma$  radiation from other parts of the reactor. The absolute photon flux is plotted as a function of photon energy. (L.M.T.)

912

Chalk River Project (Canada) A METHOD FOR STUDYING SLIME FORMATION IN RIVER WATER COOLING SYSTEMS. H. B. Newcombe, J. F. McGregor, and S. D. Simpson. Sept. 1953. 10p. (CR-B-RHC-554)

A method is described by which the factors influencing slime formation in river water cooling systems can be studied quantitatively and on a small scale. This method consists simply of passing the water through a short length of stainless steel tube packed with ceramic raschig rings and, after a standard period of time, determining the N content of the slime which develops on the ceramic surfaces. The effects of seasonal variations in the river water, sand-bed filtration, artificial warming of the water to approximately  $22^\circ\text{C}$ , and number of infective particles contained in

the water were studied. It was concluded that the rate of slime formation is influenced strongly by the amount of nutrient material which can be captured from the water, and by temperature, but is relatively independent of the number of infective particles, and that sand-bed filtration under certain conditions can reduce the rate of slime formation. (auth)

# NUCLEAR TRANSFORMATION

913  
Brookhaven National Lab.  
ACTIVATION OF NUCLEAR ISOMERS BY GAMMA-RADIATION. Garman Harbottle. [1953] 6p. (BNL-1637)  
Activation of the nuclear isomers of  $\text{Cd}^{111}$  and  $\text{In}^{115}$  is observed when samples of Cd and In are irradiated with  $\gamma$  rays from multicurie sources of  $\text{Co}^{60}$  and  $\text{Ta}^{182}$ . The cross section is in approximate agreement with that calculated from x-ray studies. Possible applications of this phenomenon to shielding and scattering studies are mentioned. (auth)

914  
Ames Lab.  
THE  $\text{Mg}^{24}(\gamma, 3p3n)\text{F}^{18}$  REACTION INDUCED BY 70 MEV BREMSSTRAHLUNG. Fritz D. Schupp and Don S. Martin, Jr. Sept. 11, 1953. 4p. Contract W-7405-eng-82. (ISC-413)  
Mg metal was irradiated with 70-Mev bremsstrahlung radiation, and the reaction products were analyzed by chemical separation techniques. Relative yield determinations are reported for the possible products resulting from the target materials used. On the assumption that all observed activity was formed by the  $\text{Mg}^{24}(\gamma, 3p3n)\text{F}^{18}$  reaction, and by use of  $\text{N}^{14}(\gamma, n)\text{N}^{13} = 1$  as a basis, the relative yield of the process was found to be 0.042. (K.S.)

915  
Harvard Univ.  
A NEW TITANIUM NUCLIDE:  $\text{Ti}^{44}$ . R. A. Sharp and R. M. Diamond. Nov. 25, 1953. 6p. Contract AT-(30-1)-1461. (NYO-6135)  
A new long-lived Ti activity has been produced by the irradiation of carefully purified  $\text{Sc}_2\text{O}_3$  with 30- to 45-Mev protons. It has been assigned to mass number 44 by identification of its separated Sc daughter. The activity decays by electron capture to an  $\sim 160 \pm 60$ -kev excited state of  $\text{Sc}^{44}$  and has a half life of  $2.7 \pm 0.7$  yr. (auth)

916  
Radiation Lab., Univ. of Calif., Berkeley  
REACTIONS OF  $\text{U}^{238}$  WITH CYCLOTRON PRODUCED NITROGEN IONS. Albert Ghiorso, G. Bernard Rossi, Bernard G. Harvey, and Stanley G. Thompson. Nov. 18, 1953. 3p. Contract [W-7405-eng-48] (UCRL-2411)  
The reaction of  $\text{N}^{14}(+6)$  ions, accelerated with the 60-in. cyclotron, with  $\text{U}^{238}$  was studied. The nuclides  $99^{247(?)}$ ,  $99^{248}$ ,  $\text{Cf}^{244}$ ,  $\text{Cf}^{246}$ ,  $\text{Cf}^{247(?)}$ ,  $\text{Cf}^{248}$ ,  $\text{Bk}^{243}$ , and unidentified Bk isotopes were observed and their half lives estimated. The type of radiation and its energy were determined. (J.S.R.)

917  
RADIOACTIVE COPPER NUCLIDES PRODUCED BY SLOW NEGATIVE PIONS AND MUONS FROM ZINC. A. Turkevich and Si Chang Fung. *Phys. Rev.* **92**, 521-2(1953). Oct. 15.  
The relative yields of five Cu nuclides produced in the  $\pi^-$  and  $\mu^-$  bombardment of Zn are tabulated, and the relative activities of three nuclides ( $\text{Cu}^{61}$ ,  $\text{Cu}^{64}$ , and  $\text{Cu}^{67}$ ) are plotted as a function of penetration depth. It is concluded that the  $\text{Zn}(\mu^-, \gamma)\text{Cu}$  has a maximum probability near  $y = 1$  and that the radioactive nuclide distribution is different from the  $\text{Zn}(\pi^-, \gamma)\text{Cu}$  reaction, where a maximum probability is at  $x = 2$  to 3. (K.S.)

918  
AN INVESTIGATION OF (d,p) STRIPPING REACTIONS. V. RESULTS FOR SOME OF THE LIGHT ELEMENTS AND CONCLUSIONS. J. R. Holt and T. N. Marsham. *Proc. Phys. Soc. (London)* **A66**, 1032-40(1953). Nov.

Angular distribution measurements have been carried out on proton groups emitted under bombardment by 8-Mev deuterons from targets of  $\text{Li}^6$ ,  $\text{Li}^7$ ,  $\text{Be}^8$ ,  $\text{B}^{10}$ , and  $\text{B}^{11}$ . The theory of the stripping process has been applied to determine in each case the orbital angular momentum  $l$  of the captured neutron. In the following list the values of  $l$  are shown in brackets after the excitation energy of the product nucleus (in Mev):  $\text{Li}^6 \rightarrow \text{Li}^7$ , ground state (1), 0.478(1);  $\text{Li}^7 \rightarrow \text{Li}^8$ , ground state (1);  $\text{Be}^8 \rightarrow \text{Be}^{10}$ , ground state (1);  $\text{B}^{10} \rightarrow \text{B}^{11}$ , ground state (1);  $\text{B}^{11} \rightarrow \text{B}^{12}$ , ground state (1), 0.95(1), 1.67(0), 3.38(1), 4.53(2). Similar measurements have been made on triton groups from  $\text{Li}^7$  and  $\text{Be}^8$  and the results compared with the theory of Newns (*Proc. Phys. Soc. (London)* **A65**, 916(1952)). The results of this and previous work on stripping are discussed. (cf. NSA 7-2907; 7-3899; 7-4472.) (auth)

919  
THE REACTION  $\text{C}^{12}(\gamma, 3p)\text{Li}^9$ . Daryl Reagan. *Phys. Rev.* **92**, 651-2(1953) Nov. 1.

A C target was bombarded in a partially converted 270-Mev electron beam. The 0.168-sec  $\text{Li}^9$  delayed-neutron activity produced in the block was compared with the  $\beta$  activity produced in a polystyrene foil bombarded in the same beam. The measured integrated cross section for  $\text{C}^{12}(\gamma, 3p)\text{Li}^9$  is  $(6.9 \pm 2) \times 10^{-6}$  Mev barn. (auth)

920  
INTERACTION OF NEGATIVE PIONS WITH MERCURY. Nathan Sugarman and Agnes Haber. *Phys. Rev.* **92**, 730-4(1953) Nov. 1.

Radiochemical separation of expected fission products from Hg irradiated with 122-Mev  $\pi^-$  mesons demonstrates that fission occurs. The fission products are distributed in yield similar to those from the fission of Hg by high-energy neutrons. The branching ratio for meson fission is about 0.5%. Tl activities found in the meson-irradiated Hg are explained as produced by secondary fast protons. (auth)

921  
ANGULAR CORRELATIONS DURING MULTISTAGE CASCADE TRANSITION OF NUCLEUS. A. Z. Dolginov. *Zhur. Eksptl'. i Teoret. Fiz.* **23**, 493-501(1952) Nov. (In Russian)

General formulas which define the correlation between directions of two arbitrary particles omitted during a complex cascade nuclear transition are derived. The formulas are obtained without the use of the perturbation theory and are then applied to analysis of angular correlations in the N-stage and  $\gamma$  cascade during nuclear reactions and radioactive decay. (J.S.R.)

# PARTICLE ACCELERATORS

Floyd Newman Lab. of Nuclear Studies, Cornell Univ.  
THE CORNELL 300-MEV SYNCHROTRON. D. R. Corson, J. W. DeWire, B. D. McDaniel, and R. R. Wilson. July 1953. 81p. Contract N6onr-264, T.O. 3. (NP-4972)

Complete design details are presented for the Cornell 300-Mev synchrotron. Component descriptions include magnet, donut, and r-f design, in addition to injection technique, timing, and circuitry. Synchrotron calibration procedures and radiation shielding studies are also discussed. (K.S.)

923  
Radiation Lab., Univ. of Calif., Berkeley  
THE ACCELERATION OF NITROGEN<sup>14</sup> (+6) IONS IN A 60-INCH CYCLOTRON. G. Bernard Rossi, William B.



Jones, Jack M. Hollander, and Joseph G. Hamilton. Nov. 18, 1953. 5p. Contract [W-7405-eng-48] (UCRL-2410)

Techniques used with  $C^{12}(+6)$  ion acceleration have been applied to  $N^{14}(+6)$  ions by changing the ion source gas from  $CO_2$  to  $N_2$  and increasing the magnetic field to resonance for  $K = \frac{e}{w_1}$  in the equation  $e/m = K(1/2n + 1)$ , where  $n = 0, 1, 2$ , etc. and  $K$  is a design parameter. This provides that for  $n = 0$ ,  $N^{14}(+6)$  is accelerated at the fundamental ion frequency ( $w_1$ );  $n = 1$  indicated  $e/m = \frac{2}{3}w_1$  which allows for acceleration of  $N^{14}(+2)$  at  $\frac{1}{3}w_1$ . Under these conditions internal beams of  $N^{14}(+2)$  have been measured to a level of  $50 \mu a$  whereas those of  $N^{14}(+6)$  are of the order of  $0.1 \mu a$  with energies greater than 100 Mev. Experiments with  $C^{12}(+2)$  in an effort to increase the  $C^{12}(+6)$  beam indicate that collision stripping is less likely than multiple bombardment by high-energy electrons. Verification of the existence of these high-energy  $N$  ions in the 60-in. cyclotron have been made by performing experiments in which isotopes of elements with atomic number  $Z + 7$  have been produced from target elements of atomic number  $Z$  and isolated by chemical procedures. It is shown that the isotopes found could not have been made from target impurities by projectiles of lower  $Z$  than  $N$ . Examples such as the production of  $At(Z = 85)$  from  $Au(Z = 79)$  and  $Pt(Z = 8)$  and  $I(Z = 53)$  from  $Pd(Z = 46)$  are used for this purpose. (J.A.G.)

#### RADIATION ABSORPTION AND SCATTERING

924

National Bureau of Standards

GAMMA RADIATION IN AIR DUE TO CLOUD OR GROUND CONTAMINATION. Martin J. Berger and John A. Doggett. June 1, 1953. 77p. (NBS-2224)

The energy spectrum and penetration of the  $\gamma$  radiation in the air above a uniformly distributed radioactive source on the ground and the energy spectrum of radiation in a large cloud uniformly contaminated with a radioactive substance were determined. The method of Spencer and Fano is applied to the solution of the transport equation. These authors use an indirect approach, applicable to infinite homogeneous scattering media, consisting of integral equations for moments, numerical calculation of the moment, and reconstruction of the density function from the moments. Emphasis is placed on computational procedures. The accuracy of the method is discussed, and a refined treatment is given in which, for the sake of increased accuracy, the singly scattered radiation is dealt with separately. (C.H.)

925

Naval Research Lab.

ANALYSIS OF SCINTILLATION SPECTROMETER OBSERVATIONS OF THE PENETRATION OF  $Cs^{137}$  GAMMA RADIATION THROUGH WATER. L. A. Beach, R. B. Theus, and W. R. Faust. Dec. 1, 1953. 10p. (NRL-4277)

Spectral modifications of  $Cs^{137}$   $\gamma$  radiations produced by penetration and diffusion through water have been observed. A single crystal of  $NaI(Tl)$  was used to observe the pulse-height distributions, produced by radiation from both plane parallel and point isotropic sources. Inversion of the pulse-height distribution was carried out by use of an analog computer to obtain the spectral distribution of radiation. (auth)

926

INELASTIC COLLISIONS BETWEEN HEAVY PARTICLES. I. EXCITATION AND IONIZATION OF HYDROGEN ATOMS IN FAST ENCOUNTERS WITH PROTONS AND WITH OTHER HYDROGEN ATOMS. D. R. Bates and G. Griffing. Proc. Phys. Soc. (London) A66, 961-71(1953) Nov.

Born's approximation is used to calculate the cross sections of the following processes:  $H^+$  (or  $H(1s)$ ) +  $H(1s) \rightarrow H^+$  (or  $H(1s)$ ) +  $H(2s, 2p, 3s, 3p, 3d$  or  $C$ ), where  $C$  represents the continuum. The results are presented mainly in

graphical form. In the case of the ionizing collisions the energy distribution of the ejected electrons is also given. (auth)

927

ELECTRON CAPTURE. III. CAPTURE INTO EXCITED STATES IN ENCOUNTERS BETWEEN HYDROGEN ATOMS AND FAST PROTONS. D. R. Bates and A. Dalgarno. Proc. Phys. Soc. (London) A66, 972-6(1953) Nov.

The cross sections associated with the electron capture processes  $H^+ + H(1s) \rightarrow H(1s, 2s, 3s, 4s, 2p, 3p, 4p, 3d, 4d$  and  $4f) + H^+$  are calculated. They are used in the evaluation of  $f_\alpha$  and  $f_\beta$ , the fractions of the total number of captures which result in  $H_\alpha$  and  $H_\beta$  emission. It is found that  $f_\alpha$  and  $f_\beta$  are very small, being only about 0.050 and 0.015 respectively, even at the most favorable impact energy ( $\sim 70$  kev). (auth)

928

THE ELASTIC SCATTERING OF 1.33 Mev and 2.76 Mev GAMMA RAYS BY LEAD. W. G. Davey. Proc. Phys. Soc. (London) A66, 1059-63(1953) Nov.

A report is given of measurements of the elastic-scattering cross section of lead for  $\gamma$  rays of 1.33 and 2.76 Mev at scattering angles between  $40^\circ$  and  $120^\circ$ . With 1.33-Mev  $\gamma$  rays good agreement was obtained with the theoretical predictions on the basis of Rayleigh and Thomson scattering alone. The Rayleigh scattering cross section was calculated from Franz's formulas which are non-relativistic and based on the Thomas-Fermi approximation to the electron distribution in the atom. With 2.76-Mev  $\gamma$  rays the experimental cross sections were compared with an unpublished curve given by Bethe calculated for the K electrons alone, in addition to the values given by Franz's formulas. These theoretical curves are calculated only for Rayleigh and nuclear Thomson scattering, and at all angles in the range investigated the measured cross sections were found to be greater than those predicted. The discrepancy is possibly due either to secondary effects, or the occurrence of Delbruck scattering. (auth)

929

NUCLEAR SCATTERING OF ELECTRONS AND ISOTOPE SHIFT. A. R. Bodmer. Proc. Phys. Soc. (London) A66, 1041-58(1953) Nov.

The volume-dependent isotope shift and the elastic scattering of electrons by nuclei are treated by a method with which they can be simply related: The result already obtained by Feshbach, that the s-wave scattering due to the finite nuclear size depends only on the volume integral of the potential due to the nuclear charge distribution, is derived in a simple manner with a clear indication of the limitations. It is shown that this is then the only information which can be obtained for energies at which only the s-wave scattering is important. The isotope shift is calculated taking into account the distortion of the electronic wave function by the nuclear charge distribution using a non-perturbation method of Broch and is reduced considerably below that obtained with the simple perturbation method. It is shown by the same method as that used for the electron scattering that the isotope shift depends essentially only on the above volume integral and on its difference between two isotopes. Using the results obtained from the scattering of electrons by Ag and Au by Lyman, Hanson, and Scott and assuming that the nuclear radius increases proportionally to  $A^{1/3}$ , the isotope shift is brought into considerably better agreement with the experimental data. (auth)

930

THE INELASTIC SCATTERING OF FAST NEUTRONS IN CARBON AND LEAD. B. G. Whitmore. Phys. Rev. 92, 654-5(1953) Nov. 1.

The inelastic scattering of 14-Mev neutrons in C and Pb has been investigated by the photographic emulsion method. In C, evidence of the excitation of the first-excited level is found, as well as excitation corresponding to Weisskopf's evaporation theory. Comparison with previous results for Pb gives no evidence for double inelastic scattering in a thick scatterer. (auth)

931

NEUTRON-PROTON SCATTERING NEAR  $180^\circ$  AT 93 MEV. W. Selove, K. Strauch, and F. Titus. Phys. Rev. **92**, 724-6 (1953) Nov. 1.

A measurement has been made with neutrons of 93-Mev effective energy of the angular distribution of n-p scattering near  $180^\circ$  in the center-of-mass system. The results show that the magnitude of the cross section approaches the  $180^\circ$  point smoothly without any sudden increase. (auth)

932

THE STOPPING CROSS SECTION OF GASES FOR PROTONS, 30-600 KEV. H. K. Reynolds, D. N. F. Dunbar, W. A. Wenzel, and W. Whaling. Phys. Rev. **92**, 742-8 (1953) Nov. 1.

The stopping cross section of  $H_2$ , He,  $O_2$ , air,  $N_2$ , Ne, A, Kr, Xe,  $H_2O$ ,  $NH_3$ , NO,  $N_2O$ ,  $CH_4$ ,  $C_2H_2$ ,  $C_2H_4$ , and  $C_6H_6$  for protons has been measured over the energy range  $E_p = 30$  to 600 kev. An electrostatic analyzer measures the energy of protons incident on a gas cell, and the transmitted beam energy is measured with a magnetic spectrometer. The gas cell is closed off with thin Al windows. Comparison of the molecular stopping cross section of the compounds with the values obtained by summing the constituent atomic cross sections shows that Bragg's rule does not hold for any of these compounds below  $E_p = 150$  kev; for NO the additive rule does not hold at any energy studied. Above 150 kev the stopping cross section of C is obtained by subtracting the H contribution from the values measured for the hydrocarbons. Average ionization potentials are calculated from these measurements. A range-energy relation for protons in air is included. Sources of error are discussed; the probable error of the stopping cross section measurements varies between 2 to 4%. (auth)

933

INELASTIC SCATTERING OF PROTONS AND DEUTERONS FROM  $B^{10}$  AND  $N^{14}$ . C. K. Bockelman, C. P. Browne, W. W. Buechner, and A. Sperduto. Phys. Rev. **92**, 665-9 (1953) Nov. 1.

Proton and deuteron groups scattered from  $B^{10}$  and  $N^{14}$  targets were measured with a magnetic spectrograph. Accurate values for the level positions up to approximately 5-Mev excitation were obtained. One level in each nucleus failed to scatter deuterons. The operation of an isobaric spin-selection rule seems to be the most reasonable explanation of this behavior. (auth)

934

EVALUATION OF THE INTERACTION EFFECT IN n-p CAPTURE. N. Austern. Phys. Rev. **92**, 670-4 (1953) Nov. 1.

It is found possible to establish by theoretical arguments that the recently measured thermal n-p capture cross section cannot all be ascribed to the neutron and proton magnetic moments, but that about  $8 \pm 5\%$  must be contributed by an "interaction" magnetic dipole moment. (auth)

935

SCATTERING AND ABSORPTION OF HIGH-ENERGY NUCLEONS. V. I. Goldanskii, A. L. Lyubimov, and B. V. Medvedev. Uspekhi Fiz. Nauk **49**, 3-47 (1953) Jan. (In Russian)

A review is presented of the present knowledge of nuclear cross sections for high-energy neutrons and for elastic scattering and inelastic collisions. A theoretical considera-

tion of interaction of nucleons with nuclei and absorption of nucleons and their connection with cosmic rays is given.

67 references. (J.S.R.)

936

ON THE SCATTERING OF FAST ELECTRONS. II. BREMSSTRAHLUNG. H. Mitter and P. Urban. Acta Phys. Austriaca **7**, 436-45 (1953) Sept. (In German)

By the same method used in Part I (NSA 7-6251) the differential scattering cross section for bremsstrahlung in the second Born approximation was calculated. On account of the vagueness of the formula some separate cases were treated. For small reflected quanta the scattering cross section for the scattering loss of electrons can be calculated. (tr-auth)

937

RADIATIVE CORRECTIONS TO THE SCATTERING OF ELECTRONS AND POSITRONS BY ELECTRONS. M. L. G. Redhead. Proc. Roy. Soc. (London) **A220**, 219-39 (1953) Nov.

The  $e^e$  corrections to the Møller formula for the scattering of electrons by electrons and the Bhabha formula for the scattering of positrons by electrons, arising from the interaction of the particles with virtual photons, are formulated by means of the Feynman-Dyson techniques. After removing ultraviolet divergences by mass and charge renormalization, the cross section still suffers from a logarithmic infrared divergence. This is cancelled by adding on the cross section for the production of a single real photon of low energy during the collision. The result is evaluated by assuming that the maximum bremsstrahlung energy radiated is small compared with the rest energy of the electron, as viewed from the laboratory frame. Non-relativistic and extreme relativistic approximations to the formulas are presented, together with the results of exact calculations for a laboratory energy of  $20mc^2$ . (auth)

938

YIELDS OF LOW-ENERGY PROTONS AND ALPHAS RESULTING FROM HIGH-ENERGY BOMBARDMENT OF Ag. Robert W. Deutsch. Phys. Rev. **92**, 515 (1953) Oct. 15.

Graphic data are presented on the angular distribution of the relative yield of secondary protons ( $5.5 \pm 0.6$  Mev) and  $\alpha$  particles ( $6.8 \pm 1.9$  Mev) from a  $12.8 \text{ mg/cm}^2$  Hg foil bombarded by 240-Mev alphas. Measurements were taken at 0, 45, and  $135^\circ$  to the incident beam, and a yield increase in the backward direction is attributed to the fact that the yields are strongly increasing functions of energy for the region near 6 Mev. The yield of protons and alphas throughout the energy spectrum of the secondaries was also determined in the  $0^\circ$  direction for the same foil bombarded by 332-Mev protons and 187-Mev deuterons. The two spectral shapes were very similar, with secondary proton maxima occurring near 7 Mev. (K.S.)

939

THEORY OF HIGH-ENERGY DEUTERON PICKUP. B. J. Malenka. Phys. Rev. **92**, 516 (1953) Oct. 15.

The theory of the deuteron-pickup scattering amplitude is developed by consideration of the idealized (p,d) process, where nuclear exchange energy, spin, and coulomb effects are neglected. (K.S.)

940

HIGH-ENERGY ( $\gamma, d$ ) REACTIONS. J. W. DeWire, A. Silverman, and B. Wolfe. Phys. Rev. **92**, 519-20 (1953) Oct. 15.

The d-p production ratios have been measured from C, Cu, and Pb targets bombarded by 310-Mev bremsstrahlung. Measurements were taken at  $90^\circ$  in the laboratory system, and a plot of the deuteron-to-proton ratio vs. energy of the product particles suggests a ( $\gamma, n$ ) or ( $\gamma, p$ ) reaction followed by a pickup process. (K.S.)



## RADIATION EFFECTS

941

North American Aviation, Inc.

## EFFECT OF NEUTRON BOMBARDMENT UPON THE MAGNETIC SUSCEPTIBILITY OF VARIOUS OXIDES.

J. D. McClelland. Issued Nov. 15, 1953. 14p. Contract AT 11-1-GEN-8. (NAA-SR-263)

Several metallic oxides have been observed to undergo an increase in paramagnetism as a result of neutron bombardment at approximately 30°C. The oxides studied were quartz crystal, quartz glass, recrystallized alumina, sapphire, MgO, BeO, and MgAl spinel. The extent of coloration is noted for each irradiated sample. The diamagnetic susceptibility of quartz, as well as the recrystallized alumina, was found to decrease while no changes were noted in the case of the sapphire, spinel, and BeO. The behavior of the MgO differs from that of other oxides; MgO turned purple in contrast to the usual brown coloration, and the rate of production of paramagnetic defects was distinctly different from that for alumina and quartz. An estimate of the number of paramagnetic defects present is made in each case. (auth)

942

## ANNEALING OF BOMBARDMENT DAMAGE IN A DIAMOND-TYPE LATTICE: THEORETICAL. R. C.

Fletcher and W. L. Brown. *Phys. Rev.* **92**, 585-90(1953) Nov. 1.

The annealing of isolated interstitial-vacancy pairs presumably introduced by bombardment is considered theoretically with special attention paid to the diamond-type lattice. It is proposed that the annealing can be divided into three stages. First, those vacancy-interstitial pairs having a small initial separation will recombine under the influence of short-range elastic forces. Second, vacancies located initially farther from their companion interstitials will wander according to a random-walk process, some of them wandering back within the range of the elastic forces and recombining but some escaping from the vicinity of their interstitials. Finally, vacancies which have escaped in the second stage will continue to wander until captured on surfaces or dislocations or by interstitials other than their own. Approximate analytic expressions are derived for these various stages. An outline is given of a more complete treatment with a quantitative solution for one particular phase of the annealing in the diamond-type lattice. (auth)

943

ANNEALING OF BOMBARDMENT DAMAGE IN GERMANIUM: EXPERIMENTAL. W. L. Brown, R. C. Fletcher, and K. A. Wright. *Phys. Rev.* **92**, 591-6(1953) Nov. 1.

Experiments have been performed on the annealing of bombardment damage in Ge above room temperature. The damage was produced by 3-Mev electrons and consisted primarily of isolated vacancy-interstitial pairs. The extent of the damage was determined by measurement of the change in conductivity of *n*-type samples. From the annealing results, the activation energy for the diffusion of vacancies in Ge was found to be about 1.7 ev. The actual annealing curves have been fitted in terms of a model of the annealing process. (auth)

## RADIOACTIVITY

944

Brookhaven National Lab.

RADIATIONS OF 13.9-min Ce<sup>146</sup> AND 24.4-min Pr<sup>146</sup>.

W. Bernstein, S. S. Markowitz, and S. Katcoff. [1953] 14p. (BNL-1644)

The radiations of Ce<sup>146</sup> and Pr<sup>146</sup> fission products were investigated with a scintillation coincidence spectrometer. The 24.4-min Pr<sup>146</sup> was shown to decay by two  $\beta$  branches

of maximum energy  $2.3 \pm 0.2$  and  $3.7 \pm 0.2$  Mev and of about equal intensity. Gamma rays of  $455 \pm 13$ ,  $750 \pm 30$ , and  $1490 \pm 40$  kev were observed; the 455-kev  $\gamma$  ray was the most intense, and the 750-kev line was shown to consist of two  $\gamma$  rays of about the same energy. A probable decay scheme is given. The 13.9-min Ce<sup>146</sup> was found to emit  $\beta$  rays of  $700 \pm 100$ -kev maximum energy in coincidence with all of the  $\gamma$  rays. Abundant  $\gamma$  rays of  $110 \pm 5$ ,  $142 \pm 5$ ,  $220 \pm 10$ , and  $320 \pm 10$  kev and weak  $\gamma$  rays of about 50, 250, and 270  $\pm 10$  kev were observed. The relative intensities and the observed  $\gamma$ - $\gamma$  coincidences are tabulated, but the data were insufficient to determine a unique decay scheme. Some of the  $\gamma$  rays were partially internally converted giving rise to Pr K x rays. (auth)

945

INTERNAL CONVERSION AND DIRECTIONAL ANGULAR CORRELATION OF THE Bi<sup>207</sup> GAMMAS. F. K. McGowan and E. C. Campbell. *Phys. Rev.* **92**, 523-4(1953). Oct. 15.

In addition to known  $\gamma$  rays associated with the decay of  $\sim 50$ -yr Bi<sup>207</sup>, two weaker emissions have been noted at 0.700 and 1.76 Mev, probably associated with the decay of Bi. The theoretical values of the internal conversion coefficients are compared with the experimental results obtained for the 1.055- and 0.555-Mev rays associated with the M4 and E2 transitions. A similar comparison is made concerning the directional angular correlation coefficients for the Pb<sup>207</sup>  $\gamma$ -ray cascade, Bi<sup>207</sup> being used in two different source forms. It is concluded that Bi<sup>207</sup> decays 81.5% to the 1.610-Mev excited state and 18.5% to the 0.555-Mev excited state in Pb<sup>207</sup>. The half life of the 0.555-Mev state was found to be  $10^{-9}$  sec. Data are consistent with the interpretation that both transitions (1.055 and 0.555 Mev) are predominantly pure multipoles. (K.S.)

946

DECAY OF GALLIUM 67. W. E. Meyerhof, L. G. Mann, and H. I. West, Jr. *Phys. Rev.* **92**, 758-65(1953) Nov. 1.

The decay of Ga<sup>67</sup> has been investigated with scintillation spectrometers, single and in coincidence. No positrons have been found, in agreement with the total decay energy of 1.003 Mev measured by Trail and Johnson. Electron capture occurs to levels in Zn<sup>67</sup> at 0.092, 0.182, 0.39, and 0.87 Mev. The 0.092-Mev level of Zn<sup>67</sup> has a half life of  $9.5 \pm 1.0$   $\mu$ sec, and the total conversion coefficient of the 0.092-Mev  $\gamma$  ray is  $0.54 \pm 0.05$ . Rough measurement of the angular correlation coefficient between the 0.21 and 0.18-Mev  $\gamma$  rays (cascading from the 0.039-Mev level of Zn<sup>67</sup>) gives  $-0.22 \pm 0.04$ . Spin and parity assignments of the Zn<sup>67</sup> levels are discussed. The present work is in essential agreement with that of Ketelle, Brosi, and Porter. (auth)

947

REALIZATION OF A MAGNETIC-LENS SPECTROMETER. STUDY OF THE RADIATION OF Au<sup>198</sup> AND As<sup>76</sup>. Pierre Hubert. *Ann. phys.* **8**, 662-708(1953) Sept.-Oct. (In French)

The rational utilization of the properties of magnetic lenses has permitted the construction of a spectrometer for  $\beta$  rays, which, because of its separation ability and its luminosity, offers the possibility of carrying out a large number of investigations. The study of the radiations of Au<sup>198</sup> has permitted the confirmation of recent ideas on the form and energy of the  $\beta$  spectrum, on the coefficients of conversion of the 411-kev ray, on the absence of less energetic conversion rays, and on the presence of the new  $\gamma$  rays of 0.67 and 1.08 Mev. It is noted that these results are in contradiction to the spin value obtained by others. The study of As<sup>76</sup> radiation confirmed the existence of three known  $\gamma$  rays of 0.55, 1.21, and 2.06 Mev and discovered two others of 0.65 and 1.41 Mev. It is possible to show that the most energetic  $\beta$  spectrum is in agreement with the theoretical values. A study of the  $\beta$ - $\gamma$  and  $\gamma$ - $\gamma$  coin-



cidences allowed the establishment of a disintegration scheme. (tr-auth)

948

ISOMERISM IN  $\text{Pb}^{206}$ . D. E. Alburger and M. H. L. Pryce. *Phys. Rev.* **92**, 514-5(1953) Oct. 15.

An investigation of the energy levels of  $\text{Pb}^{206}$ , formed by electron-capture decay of  $\text{Bi}^{206}$ , is reported. Data are given for two particular conversion lines of special interest, believed to represent transitions from the 2200.3-kev level to the 1998.1- and 1683.8-kev levels. The half life of  $\text{Pb}^{206}$  isomeric state was determined to be  $145 \pm 15 \mu\text{sec}$ . (K.S.)

## SHIELDING

949

Naval Research Lab.

SHADOW SHIELDS. E. I. Nowstrup, L. A. Beach, and W. R. Faust. Nov. 16, 1953. 6p. (NRL-4275)

Studies were made of the effectiveness of shadow shields placed between a  $\text{Co}^{60}$   $\gamma$  source and detector. Experiments were performed by observing counting rates with a Geiger tube at various distances in water from a source hidden behind conical Pb shadow shields of various dimensions. (auth)

## SPECTROSCOPY

950

Johns Hopkins Univ.

THE ZEEMAN EFFECT IN THE MOLECULAR SPECTRA OF HYDROGEN. G. H. Dieke, S. P. Cunningham, and F. T. Byrne. June 10, 1953. 27p. Contract AT(30-1)-1447. (NYO-3970)

The Zeeman effect in the molecular spectrum of H was observed for all six isotopic species for a field strength of nearly 35,000 gauss. Several thousand lines show modification in the field with many completely resolved patterns. When there is no L-decoupling, the splittings are represented by the simple theory. When there is L-decoupling, the splittings may be helpful for the evaluation of the degree of L-decoupling and other interactions. Abnormal effects occur for some lines which are related to the Paschen-Back effect in atomic spectra. In a molecular spectrum of this type the observed Zeeman effects are a valuable aid for the classification and interpretation of the lines fully as much as in atomic spectra. (auth)

951

SOME CONTRIBUTIONS TO THE ISOTOPIC SHIFT EFFECT IN THE ATOMIC SPECTRA OF THE HEAVY ELEMENTS. Walter Humbach. Translated from *Z. Physik* **133**, 589-614 (1952). 21p. (AERE-Trans-11/3/5/384)

An examination is made as to how far the definition of an isotopic shift constant (I. S. C.) from theory is justified, what physical significances are included in the I. S. C., and the principal uncertainties in the experimental data reviewed. For the nuclear volume and related effects it is shown that the definition of an I. S. C. in the form proposed by Brix and Kopfermann is significant. The constants are tabulated for the nuclear model of the homogeneously charged sphere; methods are outlined for the calculation of the constants for other models. The influence of screening by the optical electron on the deeper-lying electron shells and the importance of this screening to the discussion of isotopic-shift effects are exhaustively treated in connection with the considerations of Crawford and Schawlow. Neither the postulate of nuclear models, which diverge greatly from a homogeneous charge distribution, nor the consideration of screening effects can remove the discrepancy between the experimental and the theoretical constants as long as it is maintained that the nuclear radii of isotopes increase proportionally with the cube root of the mass number. (auth)

952

REFLECTION AND TRANSMISSION SPECTRA OF POTASSIUM-SILICATE GLASSES IN THE INFRARED. V. A. Florinskaya and R. S. Pechenkina. Translated from *Doklady Akad. Nauk, S.S.S.R.* **91**, 59-62(1953). 4p. (NSF-tr-108)

Results are reported on the transmission spectra of 2-component K silicate glasses with the molecular K content varying from 15 to 35% and of the reflection spectra of some of these glasses before annealing and after prolonged heat treatment. Results showed that from the reflection and transmission spectra of the glasses in the infrared it is possible to establish the presence of crystallites in the glass and also, in certain cases, to determine the type of their crystal lattice and the change in their number in the glass. (J.A.G.)

953

HYPERFINE STRUCTURES OF SILVER AND GOLD BY THE ATOMIC BEAM MAGNETIC RESONANCE METHOD. Günter Wessel and Hin Lew. *Phys. Rev.* **92**, 641-6(1953) Nov. 1.

An ionizer of the electron bombardment type has been applied to a beam of atoms in a magnetic resonance apparatus. The ionization efficiency for K atoms has been found to be 1 part in 3000. The new ionizer has made it possible to study the hyperfine structures and the g factors of the ground states of Ag and Au, two elements which cannot be detected by the surface-ionization method commonly used heretofore. The measurements yield the following results:

$$\begin{aligned} |\Delta\nu(\text{Ag}^{107})| &= 1712.56 \pm 0.04 \text{ Mc/sec,} \\ |\Delta\nu(\text{Ag}^{109})| &= 1976.94 \pm 0.04 \text{ Mc/sec,} \\ g_J(\text{Ag})/g_J(\text{Cs}) &= 0.99987 \pm 0.00010, \\ |\Delta\nu(\text{Au}^{197})| &= 6107.1 \pm 1.0 \text{ Mc/sec,} \\ g_J(\text{Au})/g_J(\text{Cs}) &= 1.00081 \pm 0.00005. \text{ (auth)} \end{aligned}$$

954

THE ZEEMAN EFFECT OF THE Cr GROUND STATE. P. Brix, J. T. Eisinger, H. Lew, and G. Wessel. *Phys. Rev.* **92**, 647-9(1953) Nov. 1.

The linear Zeeman effect of the ground state of  $\text{Cr}^{52}$  has been studied by means of the atomic beam magnetic resonance method at magnetic fields up to 850 gauss. The Cr atoms were detected by means of an electron-bombardment-type ionizer. By use of the known g factors for the ground states of  $\text{K}^{39}$  and  $\text{Cs}^{133}$ , the g factor of the  $^7\text{S}_3$  ground state of neutral Cr was determined to be  $g_J = 2(1.00081 \pm 0.00005)$ . (auth)

## THEORETICAL PHYSICS

955

Atomic Energy Research Establishment, Harwell, Berks (England)  
A NEW INTERPRETATION OF THE ADIABATIC APPROXIMATION. P. A. Sturrock. Sept. 1953. 7p. (AERE-T/M-88)

The customary formula for the adiabatic invariant of a slowly changing cyclic process as an integral taken over one cycle (in time) along a single trajectory may be replaced by an integral taken at a definite time but over one cycle of a phase parameter (which will enumerate a family of trajectories). This formulation is more convenient for work upon strong-focusing particle accelerators, since then one need not know explicitly the forms of trajectories between the appropriate planes of reference. This form of the adiabatic invariant resembles closely the Poincaré invariant (which is a strict invariant), and a comparison of the two leads to an interpretation of the



adiabatic approximation as the assumption that there are no preferred phases. (auth)

956

Argonne National Lab.

# ELECTRON DISTRIBUTION FUNCTIONS AND THERMODYNAMIC PROPERTIES AT HIGH TEMPERATURES.

Malcolm K. Brachman and Roland E. Meyerott. May 1953. 91p. Contract W-31-109-eng-38. (ANL-4986)

The Fermi-Thomas statistical model of the atom is modified for computation of the Rosseland mean opacity (mean absorption coefficient), where the effects of bound electrons in the deep-lying levels and those free to move from atom to atom are taken into account. High-temperature distribution functions and thermodynamic properties are theoretically treated by including the average interactions among the bound electrons as well as between the bound and free electrons. Thus, the generalized temperature-dependent Fermi-Thomas procedure is modified to include the effects of the field in which the free-electron gas moves. (K.S.)

957

ON THE NEUTRINO CHARGE OF ELEMENTARY PARTICLES. Ya. B. Zeldovich. Translated from *Doklady Akad. Nauk S.S.S.R.* 91, 1317-20(1953). 5p. (NSF-tr-124)

It is proposed that elementary particles may be characterized by a neutrino charge, which is a quantity conserved in all particle transformations, analogous to the conservation of electric charge. The consequences of this approach are discussed in relation to known data on double- $\beta$  and  $\mu$  meson decay. (K.S.)

958

# EXPECTATIONS FROM A UNIFIED FIELD THEORY.

Behram Kursunoglu. *Phys. Rev.* 92, 506-7(1953) Oct. 15.

It is pointed out that the properties of a pure field theory should be such that the constants  $e$  and  $m$  are not explicitly contained in the field equations but should be obtained as parameters in their solution, subject to certain boundary conditions. The relativistic theory of gravitation is cited as an example of such a theory, but the difficulties of passing to a quantized field have proved difficult. The transition to a mechanical theory having the properties of a quantized field is regarded as feasible, and an illustrative example is given of a possible approach, derived from unified field theory. If interactions between electromagnetic and gravitational field are assumed negligible, the antisymmetric parts of the field equations  $R_{\alpha\beta,\gamma} + R_{\beta\gamma,\alpha} + R_{\gamma\alpha,\beta} = -p^2 I_{\alpha\beta\gamma}$ , reduce to  $(\square - \kappa^2)J_{\alpha}(x) = 0$ . A discussion of the significance of the constant  $\kappa$  follows wherein the non-existence of such a constant in a unified theory implies that gravitational and electromagnetic forces are identically treated, with nothing to differentiate between them. (K.S.)

959

COUPLED-FIELD GREEN'S FUNCTIONS. J. G. Valatin. *Phys. Rev.* 92, 522(1953). Oct. 15.

A method is outlined for avoiding reference to divergent quantities in the equations of the Green's functions by extending the idea of the limiting process introduced by Dirac and Heisenberg. Further details are to be published for the equations of the quantized field. (K.S.)

960

AN AUGMENTED PLANE WAVE METHOD FOR THE PERIODIC POTENTIAL PROBLEM. J. C. Slater. *Phys. Rev.* 92, 603-8(1953) Nov. 1.

A new method is proposed for solving a periodic potential problem in which the potential can be approximated as a constant outside spheres surrounding the atoms, spherically symmetrical within the spheres. Unperturbed functions are set up consisting of a plane wave outside the spheres, joined continuously and with continuous derivative to functions

derived from the spherical problem within the spheres. These spherical solutions are linear combinations of eigenfunctions of Schroedinger's equation within the spheres, subject to the boundary conditions that the logarithmic derivative of the function of each  $l$  value at the surface equals the logarithmic derivative of the corresponding Bessel function in the expansion of the plane wave, thereby insuring continuity of the derivative of the wave function over the sphere if the function itself is continuous. The coefficients in the expansion within the spheres are determined by demanding that the expectation value of the energy of the wave function be stationary when the coefficients are varied. The secular equation connected with this variation problem can be solved exactly, leading to wave functions having the general character of orthogonalized plane waves. A linear combination of such functions is then used to build up an approximate solution of Schroedinger's equation. It is shown that the tightly bound states are handled quite differently from the conduction band and that the treatment of the conduction band can well resemble the free-electron approximation, thereby perhaps explaining the empirical success of the free-electron approximation for the conduction electrons in metals. The method can be extended to a case where the potential does not have the simple behavior postulated, by treating the difference between the actual potential and the postulated form as a perturbation. (auth)

961

THE FORMULATION OF THE KOHN-HULTHÉN VARIATIONAL PRINCIPLE IN TERMS OF THE SCATTERING OPERATOR FORMALISM. Harry E. Moses. *Phys. Rev.* 92, 817-21(1953) Nov. 1.

The Kohn-Hulthén variational principle is expressed in terms of the scattering-operator formalism. It is shown that in terms of this formalism the principle can be expressed more abstractly and concisely than heretofore. Furthermore, certain ambiguities in the usual formulation of the principle have been removed. (auth)

962

SPACE-TIME REPRESENTATION IN WAVE MECHANICS. E. J. Hellund and M. K. Brachman. *Phys. Rev.* 92, 822-4(1953) Nov. 1.

A Newtonian-like basis for describing the dynamical behavior of a system is presented. The nature of the correspondence with a Boltzmann-type statistical mechanics is shown. Application of elementary transformation theory is used to effect the results. (auth)

963

RELATIVISTIC EQUATIONS OF INTERACTING PARTICLES. A. D. Galanin. *Zhur. Eksptl'. i Teoret. Fiz.* 23, 488-92(1952) Nov. (In Russian)

The previous methods developed for problems involving bound states (A. D. Galanin, *Zhur. Eksptl'. i Teoret. Fiz.* 22, 448 and 462(1952)) are generalized. An attempt is made to simplify operators of the Heisenberg equation. (J.S.R.)

964

QUANTUM THEORY OF WAVE FIELDS. B. T. Geylikman. *Doklady Akad. Nauk S.S.S.R.* 90, 359-62(1953) May 21. (In Russian)

The interaction of a meson field with heavy particles is investigated. Hamiltonian equations are derived and analyzed for the conditions  $g^2/\hbar c \gg 1$ . (J.S.R.)

965

ON A THEOREM IN NON-LOCAL FIELD THEORIES. P. Gulmanelli. *Nuovo cimento* 10, 1582-9(1953) Nov. 1. (In English)

The Peierls formalism, which defines the Poisson brackets in a covariant way, is applied to a non-local field theory. It is shown that the Poisson brackets of the ingoing



and outgoing fields, defined with the Yang-Feldman method, are equal to those of the free fields. (auth)

# TRITIUM AND TRITIUM COMPOUNDS

966

Atomic Energy Research Establishment, Harwell, Berks (England)

MEASUREMENT OF THE RATE OF LOSS OF TRITIUM GAS FROM TRITIUM SOURCES ADSORBED ON ZIRCONIUM. J. F. Cameron. Oct. 1, 1953. 5p. (AERE-1/M-29)

Measurements have been made with a methane flow proportional counter type 1077B of the rate of loss of  $T_2$  gas from T sources produced at Harwell. For the 30-mc source used in the experiment it was found that there was a

daily loss of  $1.2 \mu\text{c}$ . This means that half of the source will be lost in 49 yr. (auth)

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Johns Hopkins Univ.

INFORMAL PROGRESS REPORT [ON THE STATUS OF THE WORK ON THE SPECTRA OF HYDROGEN MOLECULES CONTAINING TRITIUM AND RELATED SPECTRA AND PLANS FOR THE FUTURE]. G. H. Dieke. Jan. 15, 1953. 6p. Contract AT(30-1)-309. (NYO-695)

The status of the work on the spectra of hydrogen molecules containing T is discussed, and future plans are outlined. Preparation for the U absorption and fluorescence work is described. (For preceding period NYO-693.) (J.S.R.)